DOCUMENT RESUME

ED 303 213 JC 890 070

TITLE	Planning Guide for Instructional Computing.
INSTITUTION	League for Innovation in the Community Coll., Laguna Hills, CA.
SPONS AGENCY	Digital Equipment Corp., Maynard, Mass.; Information Associates, Rochester, NY.; International Business Machines Corp., New York, N.Y.
PUB DATE	89
NOTE	66p.
AVAILABLE FROM	League for Innovation in the Community College, 25431 Cabot Road, Suite 204, Laguna Hills, CA 92653 ($10.00).
PUB TYPE	Guides - Non-Classroom Use (055)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	*College Planning; Community Colleges; *Computer Assisted Instruction; *Computer Managed Instruction; Computer Oriented Programs; Computer Software; Computer Uses in Education; Curriculum Design; Curriculum Development; Facility Planning; Facility Requirements; Faculty Development; Resource Allocation; Two Year Colleges

ABSTRACT

Designed to assist academic administrators at community colleges in developing strategies for the application of computers to teaching and learning, this guide provides background information and recommendations for the design and implementation of an instructional computing plan. Chapter 1 examines computers as a topic of instruction, as a medium for task performance, and as a tool for both providing and managing instruction. Chapter 2 discusses such organizational issues and options as the administrative structure of computing services and the establishment of instructional priorities. Chapter 3 highlights issues and options related to resources and support, including the acquisition and availability of financial resources; networking; hardware; software; support services; and external resources, information, and databases. Chapter 4 discusses the impact of computer-based instruction on curriculum planning and design, student and faculty skills, and instructional design and evaluation. Chapter 5 deals with staff development options. The remaining chapters provide a guide for the development and implementation of instructional computing. Chapter 6 discusses planning considerations, chapter 7 considers ways of assessing the institutional environment, and chapter 8 focuses on the determination of needs, goals, and objectives. After chapter 9 offers guidance on organizing faculty and technological support for instructional computing, chapter 10 addresses facilities planning. Finally, chapter 11 discusses practical aspects of implementing the instructional computing plan. A glossary is attached. (AAC)

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PLANNING GUIDE FOR INSTRUCTIONAL COMPUTING

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Planning Guide
for
Instructional Computing

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Published with support from
Digital Equipment Corporation,
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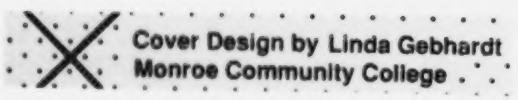
and the **IBM Corporation**



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Foreword

Addressing this decade's unprecedented surge in global competition will require massive restructuring, reallocation of resources, and development of new approaches by virtually all sectors of society. Most major corporations are striving in these ways to become more competitive. Our educational system, at all levels, must also respond by preparing our young people to face the economic and technological challenges of the age.

Current trends are not promising. The steady decline in the proficiency of our work force at routinely applying basic notions of science and technology limits our ability to improve quality and productivity—critical factors in our competitive position. Our children's interest in mathematics and science continues to decline. Compounding this problem is the serious deficiency in the number of qualified math and science teachers, and the difficulty of recruiting new, qualified graduates into the profession.

In the simplest terms, a society that is largely technologically illiterate must be transformed into one that produces more scientists and engineers, that prepares a work force capable of responding to increased technological demands, and that more efficiently expands the creation and transfer of knowledge—all at affordable cost.

Our educational system must be reformed to meet this challenge. One key to the necessary reforms is the adoption of computer-based education (CBE) as the *primary* mode of instruction in our schools and colleges. Under the direction of instructors, certified not only in particular content areas but also in the use of advanced educational technologies, a CBE program expanded beyond its current supplementary role would increase the efficiency and effectiveness of the educational system.

Computer-based education is a broad construct that incorporates various ways in which computers can be used in education, including computer-assisted instruction (CAI), computer-assisted testing (CAT), computer-managed instruction (CMI), and computer-generated administrative reports. Each of these elements and the relationships among them are discussed in some detail in the chapters that follow.

The essence of computer-based education is the direct involvement of the student at the center of the learning process and the assumption of responsibility by a student for his or her own learning progress. We know that active involvement of a learner greatly improves the odds that objectives will be met. However, our traditional instructor-centered classroom permits too many students to settle into a passive role—waiting for learning to "happen to them" rather than actively seeking it. Although it varies by grade level, much of the time an instructor spends lecturing has little effect on student learning.

Yet the expansion of CBE beyond a supplementary role does not imply a diminished role for the instructor. On the contrary, relieved of lecturing and record-keeping functions, the instructor has more time to devote to meeting the needs of individual students. Adoption of CBE as the basic medium of instruction from the primary grades through the undergraduate level would substantially increase the quality of instruction, improve learning outcomes, free instructors for more individual interaction with students, and constrain ever-rising costs of current instructional methods.

The arguments for implementing computer-based education throughout our educational system apply particularly well to community colleges. Not only do community colleges serve an enormously diverse student body, but they have emerged during this decade as increasingly important to the economic development and global competitiveness of the nation.

Community colleges enroll students from various cultural, ethnic, and socio-economic backgrounds with a host of divergent needs and intentions; most significantly, students enter community colleges with a broad range of academic skills. Computer-based education is particularly well-suited to accommodate such diversity by allowing students to work at

their own pace while providing instructors with greater opportunities to deal with differences in student needs, interests, and abilities.

Also, not only are community colleges the point-of-entry for fully half of all students seeking a postsecondary education, but these colleges are also the largest, publicly supported providers of job training and updating in the country. Faced with a situation in which the skills required of students graduating into the workforce are increasing dramatically at the same time that their level of preparedness is declining, community colleges must assure that workers are provided the skills that they need to succeed on the job. Community colleges are the last chance for thousands of underprepared students and adults to achieve self-sufficiency and to become productive citizens. It is imperative that community colleges meet these challenges for us to remain competitive in the global economy of this and the next century.

As much or more than any segment of education, community colleges must successfully integrate computer technology into their instructional practices in order to achieve the goals set for them by society. Efforts such as those of the members of the task force that prepared this monograph in order to share their insights into planning and implementing computer-based education programs are key to the success of this educational reform movement.

CBE has been effectively used in a wide spectrum of industries. Textiles, transportation, health care, and agriculture have all successfully implemented this form of instruction. This rapidly growing utilization by industry has provided the impetus to make the technology even more cost-effective and to extend the range of application. Recent advances in technology, such as interactive video, compact disks, and read-only memory, have reduced hardware costs and improved performance. Further, an already large volume of high-quality courseware is growing steadily. No longer can high costs or lack of courseware be cited as reasons for not using CBE in every classroom.

Further improvements in CBE are coming. Hardware costs will continue to decline. Advances in artificial intelligence, as reflected in expert systems simulating human intelligence, will widen the horizon of computer-based education. Of course, there will be additional developments that we simply cannot foresee.

At hand is the technology to provide lower cost, more accessible, and higher quality education and training. At hand is the technology to elevate the teaching profession and, by increasing efficiency, to provide a reward structure commensurate to the profession's importance to society. It cannot be allowed to languish in the wings.

William C. Norris
Founder and Chairman Emeritus,
Control Data Corporation

Acknowledgments

The Board of Directors of the League for Innovation in the Community College wishes to acknowledge the members of the task force who have shared their experience and expertise by developing this document. The board particularly wishes to recognize the leadership of Charles J. Carlsen, president, Johnson County Community College, and H.R. Gentry, director, Information and Computer Systems, at the same college, who chaired the task force and provided impetus and focus to its efforts.

The board acknowledges the special contribution of the companies that have joined the League for Innovation in the Community College as partners in applying computer technology to improve teaching and learning and institutional management in community colleges, especially representatives of these companies who served on the task force; William C. Norris, founder of Control Data Corporation, who graciously agreed to contribute the foreword; and Herb Cotter, director, IBM Academic Information Systems, who shared his insights on strategic planning and provided the use of the ISAAC bulletin board for writers and other members of the task force to share their drafts and comments electronically.

The board also expresses its special appreciation to its partners, Digital Equipment Corporation, Information Associates, and the IBM Corporation for their support which has allowed this document to be distributed to every community college in North America.

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Preface

The arguments in favor of using computers in instruction in community colleges are both numerous and compelling. Students need to be prepared to compete in an increasingly technological workplace and to prosper in a society literally run by computers. Business and industry need a technologically competent work force to compete in the emerging global economy spurred by the dawning of the information age. Computers offer the best hope for community colleges to individualize instruction to meet the needs of a student body that is increasingly diverse not only in socio-economic and cultural terms but also, more importantly, in academic skills and educational objectives. Computers can simulate learning environments that cannot otherwise be experienced at a reasonable cost or created at any cost. Prudent investment in instructional computing resources holds forth the prospect of increasing cost effectiveness in performance of the labor-intensive teaching and learning act.

These and other arguments have at their core the fundamental judgment that computers are simply among the best tools we have available to help students learn and teachers teach.

Purpose and Audience

The purpose of this document is to assist those who share the conviction that computers can greatly enhance the teaching and learning process to integrate computing into instruction in community colleges. The document is intended to provide practical guidance for community colleges to develop institutional strategies for applying computers to improve teaching and learning. It represents the best thinking, expertise, and experience of members of the Task Force on Instructional Computing, which was organized by the League for Innovation in the Community College to share their knowledge about planning for instructional computing with community colleges throughout North America.

With this purpose in mind, the document is addressed to the academic leadership of community colleges. It outlines the major issues facing presidents, chief academic officers, deans, division directors, academic planners, computer support personnel, and faculty leaders to implement instructional computing at their colleges. It identifies characteristics of an environment necessary to support innovative uses of computers in instruction and paints a picture of the effects that widespread integration of computers into instructional practices will have on a community college. Finally, the document provides a step-by-step process for developing and then implementing a comprehensive plan for instructional computing.

Organization

The document is divided into two major sections. Section one provides background information about the various functions of computers in instruction and identifies issues related to organizing and supporting instructional computing and options for resolving these issues. The section also discusses the impact that incorporating computers into instructional practices will have on the curriculum, faculty, and staff.

Section two provides a guide for developing and implementing an instructional computing plan. The first chapters focus on basic approaches to planning and the development of a strategic plan for instructional computing. The remaining chapters deal more specifically with implementing such a plan, with particular attention to issues of operational planning that concern instructional computing in a community college.

A glossary is provided for selected technical terms that appear in the text.

"The Community College and the Computer"

The development of this document is an initiative of a five-year project of the League for Innovation in the Community College—"The Community College and the Computer." In 1985, the League was joined by selected major computer-related corporations for the purpose of assisting League members and other community colleges in the United States and Canada to learn about and adapt computers to improve teaching and learning and institutional management.

The project has focused on three types of activities: 1) designing and developing special computer applications, 2) sponsoring an annual conference—the only major, bi-national annual conference on computing in community colleges, and 3) developing and publishing guidelines related to computing applications in community colleges. *Planning Guide for Instructional Computing* is the fourth in the series related to the project; others include *Guidelines for the Development of Computerized Student Information Systems*, *Guidelines for Library and Media Automated Systems*, and *Computerized Adaptive Testing: The State of the Art in Assessment in Three Community Colleges*.

Through work such as this, League colleges and their staffs aim to assist community colleges throughout North America to develop innovative applications of computer technology to serve better their students and their communities. This document is offered in that spirit.

Don Doucette
Associate Director,
League For Innovation
in the Community College
January, 1989

SECTION ONE: ISSUES, OPTIONS AND IMPACT OF INSTRUCTIONAL COMPUTING

Chapter One
Functions of Computers in Instruction

Instructional computing has moved significantly beyond the use of computers in the traditional disciplines of computer science, data processing, information systems, and computer repair. Today, computers are being used to support instruction in virtually every discipline. This support takes many forms, all of which can be included in the scope of instructional computing.

Because this broad perspective of instructional computing is assumed throughout the rest of this planning guide, and because each use of the computer may affect the resolution of issues and selection of options that will affect planning, the various forms of instructional computing will be briefly discussed.

Generally, the computer can serve four functions in instruction: 1) as an object or topic of learning, 2) as a medium for performing some task, 3) as a medium for providing instruction, and 4) as a medium for managing instruction.

Computer as the Object or Topic of Learning

The traditional role of the computer in instruction has been as an object of learning. In computer science, data processing, information systems, or computer repair, the computer itself is the subject matter. In these disciplines, knowledge about the computer, how to use it, or how to program it are the learning objectives.

More recently, other disciplines have included instruction about the computer or computer software. Courses on how to use specific pieces of software can be found in many subjects. For example, office career courses may teach how to use a specific word processing program. Such a course focuses on how to operate the software (for example, how to move or delete paragraphs in a document), and possibly on how to operate the computer on which the software runs. The ability to operate the computer or a particular piece of computer software is the learning objective in this use of the computer in instruction.

Computer as a Medium for Performing a Task

A computer can also provide a means for a student or teacher to perform an intermediate task that will help the student achieve a learning objective. Thus, a student can use word processing software to write an essay. The use of the computer can facilitate the instruction of "writing as a process" by allowing a student to easily edit and rewrite compositions. Here the students use the computer as a tool. Although the computer in this case does not guide learning or deliver instruction, it does provide a significant medium for demonstrating and exercising a concept.

An instructor can also use the computer as a tool. For example, a mathematics instructor may use the computer to illustrate mathematical concepts. Changes to an algebraic equation can be displayed graphically. In both cases, the teacher is using the computer primarily as an electronic display device.

The computer can also be used as an information-retrieval system. Since vast amounts of data can be stored on a computer, the machine can simplify manipulating retrieval or examination of those data. Included in this category is the use of database programs for storage and retrieval of data and statistical programs for analyzing data. Also included are decision support systems that allow a decision-maker to examine quickly the probable outcomes of alternative courses of action.

In addition, there are computer-based process control systems that allow the computer to be used to administer scientific experiments and gather data from people or special experimental equipment. The computer also can be used to control other electronic devices, for example, synthesizers or auto-analyzers.

A rather new and unique use of the computer in this vein is student use of expert systems. An expert system is a computer-based representation of some body of expertise. For example, an auto mechanics student can build an expert system that encompasses his or her understanding of the rules for diagnosing all of the causes of rough idling. The

student can then validate his or her understanding of those rules by observing whether the computer accurately performs a diagnosis. In other words, the student improves understanding by teaching the computer how to do the task.

Finally, the computer can provide a learning environment. For example, a simulated chemistry laboratory can be created on the computer. In this computerized lab environment, a student can simulate mixing chemicals and observe realistic results with no danger. A different type of learning environment is one in which a student can explore analytic geometry. Here the computer system serves as a medium for graphing algebraic expressions, instantly graphing any expression typed in by the student. By relieving the tedium of calculating points on the graph, the environment allows the student greater time and freedom to explore and examine the effects of various parameters in the expression.

In summary, using the computer as a task medium in instruction means that the operation of the computer or of a particular piece of computer software is secondary to the curricular objectives. The computer serves as a medium to facilitate teaching and learning the objectives. In this type of usage, the computer itself is not intended to guide learning or provide instruction. This use of computers appears to be most widespread at the postsecondary level.

Computer as a Medium for Providing Instruction

The computer can also be used to guide learning and provide instruction as a supplement to other means of primary instructional delivery. There are many variations in the computer's use for providing instruction. These stem from the various ways in which instructional approaches, media, and technical approaches can be combined in a computer-based system.

The most common technique is to use the computer to make a tutorial presentation of previously prepared text, computer graphics, or video. This is what is most commonly meant by the term computer-aided instruction (CAI). In a CAI tutorial, the computer can also ask the student prepared questions and select subsequent material based upon the answers. A new variation on this approach is called hypertext. In a hypertext application, the student can point to an item or word on the screen and the computer will present more material elaborating upon that item or word. Thus, a text can be multi-dimensional, allowing some students to view only the surface text while others request greater elaboration.

Some programs have used artificial intelligence techniques to add a computer-based tutor to a learning environment. For example, the computer can simulate a corporate environment in which the student is an accountant required to complete some accounting task via a calculator, journal, and other tools electronically represented on the computer. The computer-based tutor "observes" the actions taken by the student and guides him or her to the right approach by manipulating the environment, perhaps through highlighting, rewording, or changing the level of difficulty.

When using the computer to provide instruction, a variety of computer-based media can be used to implement many different instructional and technical approaches to guide the student to a given learning objective. Each combination of learning objective, media, and approaches has specific strengths and weaknesses. However, available evidence suggests that providing instruction solely via computers is not currently educationally sufficient, regardless of the combination.

Computer as a Medium for Managing Instruction

The computer's capability to store and retrieve information can be used to aid the instructor as well as the student. Computers can be used for storing, retrieving, and printing banks of test items. They can be used along with optical scanners for scoring objective tests. They can be used for keeping grade books. Computer management of instruction can be combined with computer provision of instruction to create an integrated system that can supplement primary instructional delivery by testing the student, prescribing and delivering supplementary materials, and recording student performance.

An institution's preparedness to implement the many instructional uses of computers is dependent upon its resolution of the issues and considerations presented throughout this planning guide. Its success in integrating these uses of the computer in instructional practices will be related in part to its success developing and implementing a plan for instructional computing.

Chapter Two
Organizational Issues and Options

The demand for instructional computing challenges institutions to explore new organizational structures. Community colleges must effectively address organizational matters that are critical to setting the direction for maintaining, expanding, and improving the provision of instructional computing.

Which organizational structure will work best to promote, manage, and coordinate instructional computing depends upon the institution. The structure should provide the administrative framework for setting priorities for both administrative and instructional computing services. It should also provide the framework for relating instructional computing to the overall mission of the college.

While mainframe computing power has been available to colleges for a number of years, the development of microcomputers in this decade has extended and distributed computing capabilities for both administrative and instructional uses exponentially. As microcomputers have become affordable, both individuals and institutions have invested substantially in hardware and software, and computer use has proliferated. With the rapid increase, particularly in instructional uses of computers, it has become increasingly important to formulate institution-wide policies and procedures to enhance orderly growth. College leadership needs to deal effectively with a variety of issues affecting the organization of computer use.

This section will not attempt to cover all organizational issues and considerations, which may vary from college to college. However, it will attempt to increase awareness of some important issues that are relevant for many institutions.

Organizational Structure for Computing Services

An important institutional concern is where to place instructional computing within the organizational structure of the college. There are a number of alternatives and philosophies that pertain to management and control of instructional computing, but two things are nearly universal. First, administrative leadership is essential for overall effectiveness and coordination of computing services. Second, placement within the organizational structure in large part determines communication and reporting patterns and the degree of priority given to instructional computing.

Three models are offered to provide an overview of the diversity of organizational and reporting structures currently operating within community colleges.

Separate Instructional and Administrative Computing Structures. In this model, administrative and instructional computing are maintained separately. Instructional computing is managed and supervised by a director of instructional or academic computing who reports to a chief academic officer, such that this function is not limited by reporting to a single department or division. In coordinating instructional computing use and resources, the director generally operates with the assistance of an institution-wide computing advisory committee.

The advantages of this approach include: concentration of efforts on instructional needs without competing with administrative computing; high levels of faculty participation; good access to information and resources for faculty and students; a shorter response time for requests for policy decisions, support, and resources; and effective communication between those knowledgeable about computers and the faculty.

The disadvantages of separate administrative and instructional computing facilities include: inability to address the increasing need for administrative information support; difficulty dealing with applications that are borderline between administrative and instructional uses; possible duplication of personnel; inadequate support for instructional users; incompatible equipment and software purchases due to separate organizational concerns; and lack of understanding among end users of the procedures for obtaining resources and services.

Combined Administrative and Instructional Computing Structure. In a combined administrative and instructional computing environment, one set of resources is used for both areas of computing.

This approach is generally centralized, with a director of computing services reporting to the CEO level so that neither instructional nor administrative computing suffers from a subordinate reporting relationship. Responsibility for maintaining computer resources rests with the officer who oversees both administrative and instructional computing.

Advantages of this organizational framework include: provision for well-defined and efficient operating procedures with only one set of programming personnel required to operate the system; better utilization of computer resources; and the control necessary to serve both administrative and instructional users fairly.

The disadvantages of this structure include: the possibility of bias towards either administrative or instructional computing priorities resulting in inadequate resources for the other function; unproductive competition between administrative and instructional computing; lack of direct communication between faculty and administrative computing personnel; and time-consuming meetings to resolve conflicting computing needs.

Distributed Instructional Computing Structure. A distributed instructional computing structure may result in diverse organizational environments. There may not be a designated instructional computing office; instead, the function may be carried out through distributive leadership. Instructional computing leadership personnel may be located in a single academic department or in several. Frequently, this type of administrative structure is supported heavily by committees that report to the chief academic officer. General direction, priorities, and goals originated by the chief academic officer serve as guidelines for the various departmental or divisional units.

In the committee arrangement, there is often an institution-wide committee for instructional computing that forms recommendations for the chief academic officer. Subcommittees deal with various aspects of instructional computing, such as equipment and software standards for purchasing, connectability of equipment, availability of in-house and external databases, and provision for orderly growth of instructional computing. In this environment, the financial system is probably organized according to departmental or divisional budget centers; therefore, a centralized computer coordinator would be ineffective and would have little financial control of overall computing resources. Even in this distributive environment, certain services may be provided centrally, such as maintenance, purchase of software and hardware, training, and technical support.

Some advantages of this administrative structure include: decisions affecting instructional computing are made closer to the activity; flexibility in meeting users' immediate needs; and ability to accommodate both multiple and single campus environments more easily.

Some disadvantages include: difficulty coordinating functions such as software sharing and interconnecting equipment; difficulty for each department to provide the level of technical assistance needed; greater difficulty reallocating resources; greater difficulty determining budgeting priorities; and greater difficulty standardizing hardware and software resources.

An institution must consider which of these diverse organizational structures will work best in its unique organizational climate and context.

Commitment of College Leadership

It goes without saying that regardless of the organizational structure chosen for instructional computing, the proactive commitment of college leadership is absolutely required to develop and implement a meaningful plan for integrating computing into the curriculum. The board, president, chief academic officer, and key faculty leaders need to be involved in a plan with such institution-wide impact.

The process of formulating and stating the institutional commitment to instructional computing may involve methods similar to those employed to set other institutional goals, such as forming committees and obtaining faculty, student and community input, and expert advice. A vehicle such as a task force may include representatives for all major college constituencies. Such a task force may be charged with reviewing, assessing, and prioritizing support for instructional computing; assessing the impact on curriculum and instructional delivery; reviewing and advising on hardware and software needs and acquisitions; and developing processes for collecting, evaluating, referencing, and maintaining innovative instructional computing materials. In most cases, it will serve important educational purposes and assist in developing broad-based commitment to instructional computing.

Once it is clearly formulated, administrative commitment for the support and development of instructional computing must be communicated in an institution's plan for instructional computing. This top-level commitment should be stated in the context of the mission of the institution.

Attention must also be given to establishing policies for use of computing technology and to developing procedural guidelines based on those policies. Establishing policies, procedures, and standards for computing; charting future directions; and determining the feasibility of new program initiatives are administrative functions that will allow instructional computing to receive its appropriate institutional priority and its fair share of resources.

Setting Priorities for Instructional Computing

While the computing needs of all instructional areas must be recognized, developing a method of setting priorities with regard to departmental needs is a primary administrative concern. Mechanisms to determine priorities that reflect the college's overall objectives and that promote equitable allocation of computer resources among instructional units need to be established.

However, many new computer hardware and software users may not know how to express their needs as effectively as well-established users. It can be expected that requests for hardware or software to accomplish a particular educational objective may change from year to year because the users' level of computer knowledge increases. To assist users in expressing needs, a policy can be established that allows them to state requests in terms of objectives and goals to be accomplished rather than in terms of equipment. Also, the availability of a computer specialist to work with the user in developing requests can assist the process.

Priority setting should be decided at the highest level possible to avoid decisions being limited by the interests and needs individual departments or divisions have. Careful administrative planning should be given to the process of priority setting to assure equitable consideration for requests and subsequent funding.

Other Instructional Issues

A number of other issues related to implementing instructional computing will have broad-based effects. For instance, integration of computing into the curriculum will require rethinking qualifications required of newly hired faculty and support personnel. The entry and exit skills of students will be affected, and many of the ways in which faculty, students, and staff interact will be profoundly changed. These impacts and the issues that they raise are discussed in sections that follow.

Implementing an institution-wide plan for instructional computing will raise a host of issues related to resources—how they are acquired, how they are used and by whom, and how they are supported. Consideration of these issues follows.

Chapter Three
Resource and Support Issues and Options

Institutions committed to integrating computers in their instructional practices and curricula face a variety of issues related to resources and support. These principally concern resource acquisition, availability, hardware and software options, and support services.

Resource Acquisition

Lease versus Purchase. The power, speed, and utility of computer hardware are increasing at an extremely rapid pace. Four-year-old equipment is often so out-of-date as to appear useless. In most cases, older computers will still perform the jobs for which they were originally purchased but may not be useful for newer applications. Equipment that is still in good condition can be used by groups lower on the computer knowledge/needs continuum. An institution should investigate its total computer needs rather than just purchase equipment to satisfy an isolated request; it may be possible to shift computer resources to match computing needs more closely with each computer's age and capabilities and thereby spend money to acquire current rather than outdated technology.

Another alternative may be to lease rather than purchase computers. Leased computer equipment can provide a solution to obsolescence although possibly at a higher cost. Additionally, a computer lease may provide a vehicle for partnerships with local businesses.

Individual versus Central Acquisition. Individual initiative and innovation are usually the keys to success in computer-related activities. Individual needs often require unique solutions. Although most applications will work with many different levels of equipment, forcing a new application to utilize an existing, possibly underpowered computing resource, can waste time and consume human resources. However, isolated, special-purpose purchases of hardware and software can be more expensive than resources purchased through large negotiated contracts. Also, isolated purchases may promote isolation of the user due to incompatibilities with existing resources. Central coordination of resource acquisition provides better tracking and inventory control.

Inventory and Tracking. In order to plan for future computing needs and to maximize use of current resources, an institution needs to know what resources it has, where they are located, and how they are being used. Conducting a comprehensive inventory of computer resources is a necessary task. Such an inventory can be tied to other college inventory processes, and a variety of good inventory software is available to assist the task.

Standardization. There are substantial advantages to standardizing hardware and software. By limiting the variety of computers and software, a college can capitalize on bulk buying. Additional advantages include more concentrated support efforts, transferability of resources among labs, and shorter learning curves for students and faculty.

Non-standard equipment makes it difficult to shift resources to meet changing requirements. Repair, inventory, and user-education costs usually increase when dealing with multi-vendor equipment. Many institutions try to select a few standard vendors or brands of computer equipment and software in order to minimize these problems.

However, poorly chosen standards for computing resources can lead to increased costs due to decreased competitive bidding. Standards should only be established after carefully reviewing the needs and goals of the groups to be served and the institution's ability to maintain the equipment through in-house or external repair contracts. Standards should be periodically reviewed and revised. It is important that computing standards not be barriers to innovation and change. They should simply be one method for providing support in a complex and rapidly changing technical area.

Compatibility. Compatibility requirements, like well-chosen standards, enhance an institution's ability to repair, replace, and re-assign computing resources. However, rigid demands for compatible hardware and software can stifle creativity. Some incompatibility among an institution's computing equipment is inevitable. Computing resource requirements are often dictated by the particular

choices of software applications.

It should be noted that many of the current incompatibilities between different types of equipment may not be a problem in the near future. Communication links and data file translation will soon be available for most types of hardware and software, providing the ability to pass data files easily between even very dissimilar computers.

Policies and Enforcement. Policies for selecting and obtaining computing resources should be established and adhered to. These policies should be periodically reviewed and updated when appropriate to reflect changes in technology. Enforcement can easily be accomplished within the normal budget and administrative structure. A simple "signature authority" procedure can provide most of the policy enforcement and inventory control structure that is necessary.

Extensive technical expertise is often required to fully evaluate computing resource requests. Some colleges have effectively delegated this responsibility to one or two individuals. Others have formed a multi-disciplined committee of computer users to serve as a planning and review board. Representatives from local business and industry can help assure that college standards reflect those practiced in the workplace.

Resource Availability

Central versus Distributed. Security, supervision, inventory control, and maintenance are often easier to provide for one central facility than for many distributed sites. Computer usage is seldom uniformly spread throughout a day or within a week. Central facilities usually allow for more efficient allocation of idle computer resources.

Some disciplines require intermittent but immediate access to computers during the instructional process. Distributed resources can provide more convenient access to computers with less travel time and fewer scheduling conflicts. Distributed resources allow for a more predictable environment, since there may be less uncontrolled access to the equipment. Distributed resources more closely model the environment that students will encounter after completing school.

Centralized versus Decentralized Instructional Computer Labs. Local departmental labs and central computer labs, or some combination of these, provide three alternative approaches to lab facilities. Consideration should be given to departmental needs that are similar and that could be met with general-purpose labs supporting the instructional computing needs of several departments. The general-purpose lab approach may allow for increased utilization of computer equipment and provision of more advanced computer systems. The implementation of general labs can also offer the cost savings of shared software and support resources. Shared general-purpose labs require coordination of software selection, assistance provided to lab users, hours of operation, scheduling to minimize peak loads for open lab time, and special scheduling for assigned lab hours.

There may still be situations where specialized installations may be required for effective computer use. Consideration should be given to compatibility of equipment with other specialized labs and with the general labs whenever possible.

The potential advantages of networking systems within both general-purpose and specialized labs are worth examining. Lab-to-mainframe communications capability is another consideration.

General-Purpose versus Discipline-Oriented. Certain applications require a very precise, stable configuration of hardware and software to function properly. Discipline-oriented facilities can be more easily isolated from disruptive uncontrolled modification and external controls. They can also be purchased or configured to more precisely match a specific curriculum's needs.

For many disciplines, the computer is ancillary to the primary educational objectives. These groups are usually best served by open-access, general-purpose facilities. General-purpose facilities provide greater flexibility for meeting a variety of demands with a minimum of resources.

Open-Access Labs versus Labs With Open-Access Times. Open-access labs usually guarantee students that they need only compete with other students for computer time. However, such arrangements result in less efficient use of scarce resources, since computers may sit idle for some portion of the day. An alternative is an arrangement where labs are scheduled first for class use and then opened for general student use only during unscheduled periods. This approach makes it more convenient for group use but less convenient for the individual student. Labs with open-access times force the student to compete for computer time with

classes, as well as with individual students. Since these classes may not have rigid schedules for use of the lab, times available for general student use may vary on a daily and weekly basis.

Computer Labs versus Computer Demonstration Equipment. Some classroom computer applications require each student to have access to a computer. However, some instructional applications of computers are more correctly described as computer demonstrations. Demonstrating a computer application may not require a room full of computers. Overhead projector computer display units can be an inexpensive alternative. A computer, overhead projector, and computer display unit can be transported to a regular classroom. This is more efficient than setting up special classrooms or labs for computer demonstrations. A disadvantage to moving delicate equipment from room to room is the likelihood of damaging the equipment. Also, some software packages may require a color display, which is difficult and expensive to provide with the present display units. A large-screen projection system can provide the color, but they are expensive and may be too large to move easily.

Multi-Purpose Configurations. Computers need to be housed, maintained, supervised, and utilized. For the foreseeable future, computer resources may be scarce. Therefore, multiple-purpose computer configurations may be a necessity.

Security and Supervision. Computers and peripherals are often too small and delicate to be physically secured. On-site supervision and electronic detection devices now commonly used in libraries may be sufficient to maintain the security of the inventory.

Capacity Planning and Monitoring. Advanced planning and constant monitoring are essential to satisfy the continually changing and expanding demand for computers. As computers are integrated into more curricula and new teaching techniques evolve, demand patterns for lab and demonstration facilities will change and increase. The most commonly observed effect of giving instructors access to a single computer in one term is that they want thirty the following term. Planning and monitoring is essential to justify requests for increased budgets for computer resources.

Equitable Access and Scheduling Priorities. Disciplines that have traditionally had virtually unlimited computer access are often resentful of the requests for lab access by newer computer users. Equitable access across the institution is a necessity if computers are to be integrated into the general college curriculum. Effective scheduling and reasonable scheduling priorities can minimize the stress of conflicting demands.

Networking Resources

Connected versus Isolated. Isolated computers cannot share data unless the user physically carries a storage media, usually a diskette, from one location to another. Isolated systems generally can maintain privacy and security more easily than connected systems. Connected computers more closely model the information-oriented society, specifically in its use of the telephone as a communication vehicle. Electronic connections to common databases are usually more efficient than maintaining separate individual data storage facilities. Connecting computers into communication networks may be more expensive than leaving the computers isolated, but a network can provide productivity gains that can offset the added expense. Network technology is in a rapid state of growth and development. Less expensive networks will soon be readily available. These will virtually eliminate expense as an argument against communication networks.

Hard-Wire Connection versus Phone/Dial-Up Access. A hard-wired (physically connected) connection to computer resources provides more privacy and security for institutional databases than remote telephone access. Educational institutions have an obligation to maintain security on student information databases, as well as on their own financial records. Dial-up access into the school's computing resources should be allowed only after security procedures have been studied, designed, and implemented to guarantee appropriate safeguards. Although remote access to computer resources has the potential for abuse, it is certainly the direction being taken within the general computing community and greatly increases flexibility of computing applications.

Data Privacy versus Downloaded Information. An institution must safeguard the privacy of many of its records. However, not all college data must be restricted. Some data, such as class rosters, if allowed to be downloaded for use on personal computers, could increase instructors' productivity. Each institution should discuss and implement a

policy for what data will be allowed to be downloaded and how data privacy and security are to be maintained.

Electronic Mail. Electronic mail can be used to deliver college-wide announcements and personal messages, maintain user calendars, and schedule meetings. Students can deliver assignments and communicate with instructors using an electronic mail system. Instructors can use electronic mail to return graded assignments to students, deliver instructional material to an office pool for reproduction, and schedule appointments with students.

Print Queues. One printer per personal computer is generally an unnecessary expense. There are a number of different ways to connect several computers to central printing facilities and to maintain a print queue, including network file servers, "smart" data switches, and so on.

File Sharing. Shared data files and network versions of software packages can be more cost effective than individual copies of each item. Common access to large shared databases can provide disciplines with more realistic models to investigate.

Multi-User Operating Systems. Multi-user operating systems are more commonly available now than they were in the past. They are no longer available only on large mainframe systems. Multi-user microcomputer systems can often be more cost effective than individual personal computers. Multi-user systems are best utilized with applications such as word processing and spreadsheets, which are not as computer-intensive as applications such as computer-aided drafting or desktop publishing.

Distributed Processing. For applications that intermittently require extensive computer resources, distributing processing across a network may be less expensive than buying powerful individual workstations. In a distributed processing environment, a computer that is not being used to its capacity may have some of its computing power "borrowed" by applications that require more computing resources than can be provided by their host computers. However, current computing technology has not progressed to the point where distributed processing can be easily implemented.

Bulletin Board and Database Access. On-line computer conferences, electronic mail, regional and national databases, and public-domain software are all available to anyone with a computer, modem, and access to a phone line. All increase awareness of global communication networks being developed. However, the cost of providing such services can be prohibitive.

Some services charge substantial periodic fees plus telephone line costs for each use. Only a very few bulletin boards and databases are supported by sponsors rather than users. A careful analysis of the cost versus benefits of each on-line option should be calculated. One possible alternative is to provide access to internal databases stored on large-capacity optical storage devices.

Hardware

Purchase versus Manufacture. Purchasing commercially manufactured equipment is certainly the most convenient method of obtaining computer resources. Computer clones are potentially inexpensive alternatives to brands from major manufacturers. Recently, some institutions have found that they can inexpensively assemble personal computers from components purchased from mail-order computer suppliers. The deciding factors for which acquisition method to use are usually reliability and maintenance costs rather than the original purchase price. A technical staff with the time and expertise to build computers is also an obvious prerequisite to manufacturing in-house equipment.

Peripherals. In many cases, the cost of computer peripherals is far greater than the cost of the computer. Many new sophisticated applications require sophisticated and expensive equipment to run them. A desktop publishing package may require a full-page display screen, a laser printer, and an optical scanner. Interactive video requires specialized connectors and controllers. Computer-aided drafting requires high-resolution monitors and plotters. Careful investigation of all the components needed in specific applications is essential before the purchase of the base computer, which may be just a portion of the total cost involved.

Maintenance Cost. Institutions often think of the purchase price as the only cost of a computer. Surveys of business users of computers reveal that maintenance costs often equal or exceed the original purchase price over the life of the machine. Internal maintenance programs can supplement or replace external service agencies depending upon the number of computers to be serviced and the availability of parts to non-franchised repair units. Maintenance handled internally also increases the

technical knowledge base at the institution.

In-house computer maintenance has often been seen as the duty of existing media staff, who typically repair audio/visual and other instructional equipment. Adding computer repair to this type of operation has frequently diminished the overall quality of service by spreading the repair staff too thin. The savings realized by in-house repair can offset the increased demands on the staff by financing the hiring of part-time personnel to maintain the quality and quantity of college-wide repair services. The hidden costs of repair services must carefully be analyzed before any long-term policies are established.

Replacement Cost. Computers have a useful life of from three to five years. It is important to recognize computers as a consumable resource when projecting future costs. From a user-power-per-dollar perspective, every year for the last ten to fifteen years has produced large increases in power and capacity for relatively small increases in cost. However, users tend to require this increased power as they become more sophisticated.

Plans for systematic replacement of computers should be staggered over a reasonable replacement period whenever possible. Unfortunately, many computers located in laboratories or classroom clusters should be replaced *en masse* in order to insure the continuance of uniform instruction using similar machines and to guarantee that new-generation software will work on all machines. This policy may necessitate extensive equipment dollars going to one unit of the college while others receive little or nothing in a given year.

Recycling Equipment. As new, more powerful computers are purchased to replace existing equipment, the old equipment should be recycled to other areas of the college. As noted earlier, even an old computer still performs the tasks for which it was originally purchased, and it may also be put to many innovative new uses. In order to keep costs down, some colleges have promoted the concept of "cascading technology" in which previous owners have the responsibility to teach their discarded systems to the new owners before their requests for new technology are supported.

Curricular Requirements. Disciplines that require computers to support directly their curricula must be in a position to define their hardware environment. They should not necessarily decide the general-purpose computer environment for the whole institution, nor should the college insist that they conform to a college standard that may be adequate for general use but lacks the power and sophistication necessary to support specialized computer-based curricula.

Marketplace Distinctions. The needs of business users are different, but related to the needs of educational institutions. Universities and research institutions have different needs than teaching institutions. All are concerned with computing, but not in the same manner. Each segment must be responsive to the other's needs, but not wedded to them. Business departments, for instance, may find it necessary to train students on systems more popular in the business world. Community colleges with large populations of transfer students may want to coordinate their selection of systems with those used by the transfer colleges or universities.

Technological Directions. Most institutions do not have the funding base to be at the leading edge of technology. However, educational institutions must be willing to experiment with new technologies and to invest, wherever possible, in emerging educational technologies. Not all initiatives will be successful, but colleges must be willing to make the commitments necessary to advance educational goals.

Software

Centralization and Inventory. Procedures for purchase of software need to be established. In some situations, software purchasing may be centralized within the current purchasing structure. Centralization of purchase implies a focal point for review, classification, and order preparation that can capitalize on quantity discounts and standardization based upon requests from multiple departments. Centralization may also lead to a potential sharing of software between departments as a collective list of purchases is accumulated and distributed.

Whether centralized software purchasing is used or not, a procedure for software inventory is important in order to supply each department with access to all software available campus-wide. A potential avenue to accomplish this is to allocate resources to an existing library department with cataloging experience. As the amount of software on campus increases, having all programs included in a catalog system should prove to be a very valuable resource for users and a necessity for accurate inventory

record maintenance.

Purchase versus Develop. If needs are met by existing software, it would be wasteful to "re-invent the wheel." For example, no institution should develop its own word processing software, since there is an ample supply of such tools already available. Institutions should invest only in those areas of software development where no acceptable alternatives exist.

An institution thinking about developing software should consider the commitment of time required from faculty and staff. Resources may have to be dedicated to a development project in the form of released time, overtime pay, or extra service by faculty. If external distribution of developed software is a possibility, questions that must be addressed include: who will negotiate distribution rights? how will royalties be handled? and who owns the software? Other considerations include the technical level of the faculty in the use of software required for the development project, the availability of authoring tools and adequate support personnel and services, the projected lifetime of the software being developed, the development cost, evaluation of alternatives, and expected volume of usage. Colleges that undertake to develop software should proceed knowing that in most respects the costs, benefits, and risks are similar to those borne by commerical software developers.

When evaluating purchase of software, many of the same factors need to be addressed. Additional factors to be considered are: purchase price, multiple-copy cost, adaptability to the course for which the package is being considered, extra faculty/staff work required to incorporate the software into the course or courses, availability and cost of upgrades, and potential equipment upgrades necessary to run the software.

Commercial versus Shareware versus Public-Domain. The questions that determine the selection of any piece of software are: does it meet a need? has it been sufficiently tested to be reliable? and what is its cost? The escalating costs of some commercial software packages can be ameliorated somewhat by site licenses and educational discounts. Inexpensive but mature shareware packages often will offer 90 percent of the capabilities of a popular commercial program at roughly 10 percent of the cost. The principal liability of public-domain software and some shareware is the lack of documentation and rigorous testing prior to distribution.

Reduced Learning Curve. The biggest problem related to computer software is the time necessary for the user to become productive. Integrated or connected software packages with a common user interface reduce the learning curve for each new function to be mastered. An alternative to lengthy learning curves is to select an operating system with a consistent and easily mastered user interface.

Copyrights and Ethics. An institution must adhere to a visible public position on upholding whatever copyrights, patents, and other legal protection are claimed by the authors and/or distributors.

Replacement and Update Costs. An institution should have some funds set aside in each budget for revisions and updates of existing software packages. A figure of roughly 5 to 20 percent of the annual software budget should be sufficient. When truly revolutionary software emerges, special budget considerations may be needed to support the purchase of large numbers of new programs.

Curricular Requirements. As with hardware, disciplines that require computers to support directly their curriculum must be in a position to define and defend their choice of a software environment. They should not necessarily decide the general-purpose software environment for the whole institution, nor should they be required to conform to a general college standard which may be inferior to their needs.

Marketplace Directions. The institution, in general, and disciplines, in particular, must constantly observe new software directions and trends in the marketplace. The standard curricular review process must be focused on the rapid changes that have occurred in software. Old systems have undergone major revisions, new design strategies have been employed, and revolutionary concepts have created new applications for computers. Community colleges have not historically been major sources of research and development in software design. Nonetheless, they must stay abreast of developments in educational technology and contribute to such developments as possible.

Support Services

Administrative Support. The leadership and administration of a community college should be charged with developing policies and procedures related to academic computing. They are ultimately

responsible for creating and monitoring the budget. An institutional computer steering committee should be established that is comprised of representatives from instructional computer users, technical support personnel, administration, and staff. This steering committee should be charged with establishing, implementing, and evaluating policies dealing with hardware and software standards, inventory control, resource acquisition, and resource allocation.

Technical Support. Technical support personnel will vary greatly with the structure of each institution. While larger colleges may have specific personnel to provide this service, smaller institutions may utilize a variety of individuals who supply this technical support function as an add-on to their primary responsibilities. The technical support provided by an institution often determines the speed with which academic computing progresses, as well as its ultimate quality.

Technical support personnel, with the assistance of computer users themselves, should be responsible for advising, making referrals and recommendations, and arranging for training of new computer users. The technical support area should keep a detailed hardware inventory of instructional computing resources and arrange for maintenance on that hardware. They should arrange for hardware and software vendor demonstrations and, with the aid of instructional computer users, they should review and evaluate hardware and software for possible inclusion in institutional standards. Finally, as instructional computer users become more sophisticated, technical support personnel should provide consulting and programming assistance to assist faculty in development of innovative projects.

Peer Support. One of the most effective methods for facilitating peer support at any institution is an active computer user group. The user group can provide in-house software demonstration fairs, manage special interest groups, and publish a question/answer format newsletter. The user group can assist the institutional steering committee by reviewing and evaluating proposed computing projects. It can assist the technical support personnel in providing advice, referral, recommendations, and training to computer users, as well as participating in the evaluation of hardware and software.

Library Support. The library can be used to house computer support resources such as software inventory records, resource documentation, self-help tutorials, and interactive video systems. Libraries can also provide on-line database search capabilities within the scope of their budget limitations. Students may be asked to pay for the use of selected, and sometimes costly, services.

Automated libraries with on-line catalogs and computerized referencing techniques will become commonplace over the next decade. CD-ROM drives and other optical disc equipment are already being introduced as peripherals to computers in many libraries. The incorporation of these emerging technologies will find natural applications as research tools in college libraries. Colleges should make an effort to provide state of the art electronic research techniques to the best of their ability in order to prepare students for work in an information society.

Media Services Support. Media services should house, manage, and schedule all movable computer equipment, projection systems, and large-screen monitors. In cooperation with the library, media services may also furnish a variety of educational media, such as films, videotapes, and videodiscs, on the subject of computer literacy and specific applications within disciplines. In addition to these basic support services, a variety of other institutional mechanisms can be organized to support faculty and other users to integrate computing into their instructional practices. These are discussed in other sections of the document.

External Resources

There are a variety of resources external to the institution that might help support the costs of implementing instructional computing. In addition to external funding for equipment and other computing costs, information resources are also available from external sources that can substantially support efforts to integrate computers into the curriculum.

Partnerships with Business and Industry. Partnerships with vendors can work to the advantage of both parties. By investing in the introduction of computer resources in an institution, vendors develop long-term relationships that retain substantial business for years. It is important that the terms of the partnership be fully communicated at the beginning of any relationship, for clear expectations are essential for the success of the partnership. When external funding is accepted, all of the terms of the

grant or agreement must be fulfilled.

Equipment that is very expensive, or equipment that cannot be fully utilized by the staff and students but is necessary for a program, can be shared with business and industry. Negotiating the use of time on equipment residing with a business, or sharing institutional equipment for business use, helps consolidate community relationships, with benefits that may spill over into other areas. Sharing of equipment may bring faculty into closer contact with business and industry and serve a renewal function.

Business and industry can also be an important source of members for advisory committees for college programs. Program advisory committees are essential to stimulate faculty and keep them aware of current needs regarding the use of technology in business and industry. Committee members may be very useful in suggesting applications, recommending equipment, assisting with industry visits for faculty and students, and lobbying funding agencies.

Grants and Foundations. There are several sources of grants for higher education. In fact, a large part of the development and progress of instructional computing is due to the availability of computer resources from private and public sources external to the college. Private business foundations have become aware of the value of computers integrated into the teaching process and have become an important source of funds for institutions of higher learning. Public and not-for-profit institutions have also been sources of external funding; the National Science Foundation and the Annenberg/CPB Project, for instance, have historically supported the development of technological applications for higher education.

External Information and Database Resources

As the faculty become aware of how they can integrate computers into their curriculum, they will need to locate sources of appropriate software. In fact, faculty members must be provided the opportunity to learn how computers can be used in instruction, provided information about where to obtain useful software, and given an opportunity to evaluate instructional software, if they are to support and assist the integration of computers into the curriculum.

There are several available sources of information relating to the use of computers in the curriculum. Some are supported by computer companies, such as the ISAAC bulletin board and information system and its related Community College IBM Information Sharing System (CCIISS) sponsored by IBM. User groups that shape information about software applications have proliferated, and these are often supported by companies such Digital Equipment Corporation, Control Data Corporation, and Apple Computer.

Other sources of information are supported by organizations, such as EDUCOM and the League for Innovation in the Community College. Independent sources are also available, including a host of computer-related periodicals.

Software Exchanges. Databases and other sources listed above deal with information. Software exchanges, along with commercial vendors, actually provide instructional software. Several states share software and information concerning software among the state installations; North Carolina is one such state. Kinkos, a commercial organization, is a distribution activity for user-written Apple software. WISCWARE, a University of Wisconsin activity, is a source for high-quality, low-cost, user-written software for IBM computers. The Clearinghouse is a distribution center for educational software using Digital's VAX family of computers operated by Iowa State University. There are many more similar activities that serve to remove the barriers that lack of information can pose to instructional computing. It is important that college staff responsible for instructional computing make provisions to benefit from external resources available to support their program.

Chapter Four
Impact on Curriculum

Institutions looking to integrate computers into instructional practices across disciplines should realize that such integration will have significant impact on the college's curriculum. Using computers in instruction will affect basic elements of the teaching and learning process. Modifications in course content, instructional strategies, program requirements and organization, faculty qualifications, and curriculum development and evaluation processes may be required.

Academic leaders need to consider the impact that instructional computing will have on the curriculum in order to plan effectively to address instructional issues and meet student needs.

Designing Curriculum for Students

Students entering community colleges are increasingly diverse. They come from various cultural, ethnic, and socio-economic backgrounds. They represent all ages and are involved in various pursuits in and out of the classroom. Most significantly, community college students possess a broad range of academic skills and have a host of divergent needs and educational objectives.

The attributes of computers have special relevance for providing instruction to community college students. Computers can provide interactivity; immediate and individualized feedback and reinforcement; learner control and objectivity; and the capacity to collect, store, and analyze student responses. These characteristics can enhance the learning process and can assist instructors to provide personalized attention to specific student needs.

However, students also expect sophisticated instructional programs and professional-looking delivery modes because of the dynamic, high quality of today's videos, arcades, and media, as well as the technological sophistication of the workplace in which many community college students participate. Designing a curriculum that integrates computing into instructional practices for those students requires attention to some basic principles.

Learner-Focused. Curriculum needs to be learner-focused, not technology-driven. Instructors can be tempted to use computers in their classrooms because of a fascination with the medium. However, the temptation must be avoided unless instructional intent, content, and learner outcomes justify computer use. For example, when using computer-assisted instruction, a student cannot be expected to read screen after screen of text without feeling bored, weary, or manipulated. Another medium or technological application may be better suited for the content or the instructional objective.

Learning Styles. Students have different learning styles and rates. In order to attend to students' specific needs, faculty who wish to integrate computers and software into their courses should keep abreast of new developments in learning theories and concepts, especially as they apply to instructional technology.

However, they must plan for the fact that not all students learn well on a computer all the time. Some may desire human interaction or note-taking to help the learning process, and some may learn better using audio instead of visual media. Judgment is important about when, for whom, for what, and where the computer works best. A faculty member needs to examine whether his or her discipline lends itself to computer use.

When appropriately integrated into instruction, students can achieve a sense of mastery over the computer and develop its use as a natural extension of themselves. A computer should be a tool that a student will automatically use for learning or for accomplishing an assigned task, just as one would use a calculator or a pencil.

Student Access. Student access is vital if computers are to become integral to the teaching and learning process. Academic planners need to look at ways in which students can use the computer at home, after hours, and on weekends to insure educational equity and quality, to promote application of knowledge and skills, and to provide meaningful practice as part of the learning process.

Student Expectations. It is important to communicate effectively to students the ways in which computers have been incorporated into curriculum. Students tend to have preconceptions about the way

teaching and learning should be carried out, particularly if their experiences lead them to expect continuation of previous instructional practices. Students and potential students need to be informed if curricula use media such as computers.

Conversely, as computers are becoming more accessible in elementary and high schools, students come into a college environment with the expectation of using computers. Institutions that have not incorporated computers into instructional practices need to be prepared to deal with such expectations.

Student Skills

Using computers in instruction requires careful consideration of the computer skills that are required for students to succeed in college courses and programs. Other issues concerning testing and students' ability to complete tasks with and without the aid of a computer also come into play.

Entry-Level Skills. Each discipline must identify basic computer competencies required of students for success in courses or programs that have integrated computers into instruction. Systems to assess entry-level computer skills and to provide training to bring students up to required competency levels need to be developed and implemented; comparable systems have been developed to assure basic skills in reading, writing, and mathematics necessary to succeed in specified courses and programs.

In many courses, primarily those in which computers are used primarily as tools or media for providing instruction, neccesary computer competence can be provided to students in initial class sessions, including simple keyboarding skills. Only in those courses in which computers are the subject of instruction are prerequisite skills likely to foreclose student access to instruction.

Exit Competence. Computer skills required of students upon completion of courses and programs may be defined by each discipline. Departments and instructors may disagree on the minimum computer competencies that students should have, as well as on the nature of the computer skills that should be required. However, computer literacy requirements have become important components of general education requirements in many community colleges.

External factors can influence the determination of computer skills required of students for program completion. The requirements of the work force should determine the specific competencies for programs designed to prepare students for specific jobs. General expectations regarding students' computer skills can be assessed from local employers. Also, the requirements of four-year colleges and universities at which students may pursue further higher education can assist in determining the general level of computer skills that should be required of students upon program completion.

Testing Skills. The use of computers as tools has raised a variety of issues related to the tasks that students should be able to accomplish with or without the aid of a computer. For instance, faculty need to decide when students may use software to check spelling, grammar, and other discrete rule-based systems as part of the learning, teaching, and testing processes. Many teachers may feel that such aids confound the learning or testing process and make students overly reliant on technological aids.

This same issue has been argued in mathematics and statistics instruction since the advent of inexpensive calculators and access to sophisticated programs to perform statistical analysis. The balance between learning to perform a skill unaided and the ability to use tools efficiently to perform operations as part of a larger task needs to be found in each discipline.

A related question is whether testing should be modified to reflect the computer as an instructional tool or medium. Should student performance be measured differently if instructional computing processes or tools are used? For example, should faculty teach or test a student's design work in the same manner when the student uses a T-square versus a computer-aided design system?

Faculty Skills and Roles

A college planning to integrate computers into instructional practices throughout the curriculum needs to examine the skills that will be required of faculty and the various roles that faculty might play in the instructional process.

Computer Skills. As levels of computer skills are necessary to define for students, they may also be necessary to define for faculty. However, not all faculty need to possess the same sophistication in order to implement computing into the curriculum. Faculty need to learn how to operate the hardware and software that they use in their classrooms; their own levels of interest will determine the extent to which they broaden the technology with which they are proficient.

Faculty who teach about computers certainly need to be experts in their subject areas. As role models for students, they need to be among the leading college experts in computing and its use in instruction. On the other hand, faculty who do not use computers in their instructional practices probably need to have some minimal level of computer competence so as to assist students in their use of computer resources located in various support centers, such as learning labs, media centers, and libraries, and throughout college operations.

In order to assure the skills required of faculty, both staff development programs and hiring practices need to focus on clearly defined expectations for faculty and instructional support staff. A staff development program needs to recognize that faculty begin with different levels of skill and require different skills to be effective in their various roles. Hiring practices need to include carefully defined qualifications for each faculty position, which are continually updated to reflect changing technology and requirements.

Faculty Roles. Using computers in instruction provides the opportunity to rethink the role that faculty play in the instructional process. There is considerable debate as to whether computer-driven learning systems can substitute effectively for faculty as the primary means of instructional delivery. However, there is clear consensus that computers allow faculty the opportunity to redefine their roles in instruction in fundamental ways.

In the most limited sense, faculty can be information sources or delivery devices—lecturing and providing information to students in other ways. Because computers are well-suited to providing information, faculty can choose instead to become instructional facilitators and role models—using and integrating computers in their classrooms.

Computers also provide faculty with the opportunity to foster the development of higher order thinking skills, experimentation, and creativity. For instance, faculty can teach problem-solving skills because of concepts and skills inherent to computer usage, such as building upon the work and information of others, communicating with other sources to get help, and refining solutions through debugging techniques and systematic experimentation. Using computers in instruction also provides a case study of the effects of the application of new technology on people and processes that have previously been conducted differently.

Curriculum Planning

Prior to redesigning or developing courses and programs to incorporate instructional computing, colleges need to develop plans that include external as well as internal constituencies affected by curriculum changes. Collaboration among faculty from high school, community college, and university sectors can aid the development of a cohesive curriculum that assures articulation of programs among institutions.

Also, to assist effective curriculum development, college planners should involve advisory committees and develop partnerships with business, industry, government and community agencies, and other organizations with interest in graduates with computer skills.

More than other institutions of higher education, community colleges have historically been willing to revise their curricula to meet the changing needs of society. The introduction of ever-changing computer technology into instruction will require even greater flexibility. Curriculum planners need to incorporate mechanisms for continuous review and revision of delivery systems to remain technologically current. Curriculum development policies and procedures may need to be modified to accommodate revisions due to changing technology.

Instructional Design

The development of programs, courses, instructional materials, and other elements of a curriculum are substantial undertakings. Most institutions have policies and procedures for curriculum development, and many also provide instructional design assistance. The development of instructional software or courseware and the various uses of computers in instruction raise a host of issues related to instructional design.

Authoring tools allow non-programmers and novice computer developers to produce their own courseware. However, these tools usually do not include sophisticated instructional design considerations or techniques that make the development process more efficient and less frustrating. Developers should take care not to create "automatic page turners" or to recreate existing software.

Before considering courseware development, several preliminary steps need to be taken. First, the need for new courseware must be analyzed, particu-

lary in terms of the benefits to students and the cost of development and implementation. Those interested need to review carefully and seriously whether necessary resources (time, money, tools, programming or data-entry support) are available. Often it is less expensive, more efficient and easier to buy existing commercially-developed courseware that can be integrated into a course. However, integration of such courseware also needs to be planned, and faculty need to evaluate its value for students in light of its cost.

Also, before development begins, the content, learner characteristics, instructional goals and objectives, practice activities, and information needed to achieve the objectives (rules, definitions, descriptions, principles, concepts, procedures, examples and non-examples) should be identified and narrowed. Then, a map or "big picture" of the lesson structure should be created.

Developers may want to verify the support planned for delivery of the software (such as labs, technicians, modifications of facilities and scheduling and access to computers) so that their software or courseware can be implemented once developed.

A team approach to software development or integration of commercial courseware is highly recommended. In such a team, faculty primarily serve as content or subject-matter experts. An instructional designer, working with faculty, identifies the structure, format, decision or branching points, and options for the program. A systems analyst establishes the code structure. A graphic artist provides pictorial and presentation format and program packaging, and a project manager leads the process and facilitates the group. These roles and responsibilities are important components of the organizational and working structure of the development process. Distinct tasks for developers need to be agreed upon before the project begins in order to avoid redundancy in work efforts.

Faculty and instructional designers should ensure that lessons and activities include learner control, interactivity, immediate and personalized feedback, reinforcement, and motivational elements that enhance the learning process.

Field-testing of programs with students, formative evaluation, and revision of the program should be part of the development process. Instructional designers should work closely with faculty and administrators in the final implementation and dissemination processes so that the program is used within the scope and intent of the curriculum for which it was designed.

Evaluation

Evaluation to insure the quality and assist improvement is an important component of any curriculum. It is particularly important to evaluate the effectiveness of new instructional methodologies, including the effectiveness of integrating computers in instructional practices.

Sound evaluation practices that apply to all courses and programs also apply to those using computers as a significant part of the instructional process. Course and program evaluation should include both review of instructional process variables and analysis of student outcomes. Student persistence, test scores, and other measures of achievement need to be reported. Student preferences and evaluations of materials, methodologies, and instructors should also be collected in order to evaluate effectiveness.

The evaluation of software or courseware used in instruction becomes an important additional concern as colleges integrate such technology into instructional practices.

Of course, software should be carefully evaluated prior to being used in instruction. Evaluations of other users can be requested to inform the process. As much as feasible, software should be carefully evaluated under classroom or laboratory conditions. Software should also be evaluated for bias, controversial activities, questionable instructional methods or paradigms, and appropriateness for certain student populations.

Once implemented, software should be regularly reviewed to determine its effectiveness in assisting students to achieve instructional goals. Student behavior using software can be observed to determine its ease of use; behavior before, during, and after use can sometimes provide important information about both planned and unplanned outcomes of using computers as part of the instructional process.

Finally, some evaluation must be made to determine whether the benefits of using computers in instruction justify the costs. Although benefits to students are sometimes difficult to quantify, both long-term and short-term cognitive and non-cognitive outcomes need to be considered in evaluating the effectiveness of using computers in instruction.

Chapter Five
Staff Development Options

Integrating computers into instructional practices involves people at all levels of the organization. It challenges basic concepts and assumptions about teaching and learning. There is a real fear by some that adoption of instructional technology will make some teachers obsolete.

The impact on staff should not be understated. As has been previously discussed, faculty qualifications and roles need to be reconsidered in light of the skills required to use computers in classrooms and laboratories throughout the college. Specific levels of skills required for different positions need to be carefully defined. In some cases, individuals will need to be reassigned and additional staff employed to provide technical and design support.

In all cases, however, the decision to implement instructional computing requires the establishment, re-direction, or expansion of staff development programs to provide current staff with new knowledge and skills and to assist them in keeping current with developments in technology. There are options for organizing and implementing staff development programs to support instructional computing, as well as numerous issues to be considered in planning an effective program.

Adult Learners

Faculty learning to integrate computers into the curriculum are adult learners, and therefore all the forces and considerations of adult learning come into play. Learning occurs best when it is relevant to the learner. In the case of instructional computing, it occurs when hardware or software is available and when instructors identify specific needs that can be met by technology.

Like students, faculty members have individual learning styles that must be respected and accommodated. Some people are experimenters, and some are observers. Some want clear directions, and others need general concepts. No one program will fulfill all needs, and a comprehensive development program to assist faculty to use computers in their classrooms must be designed to accommodate a range of learning styles using a variety of formats.

Institutional Commitment

Given the crucial role of staff development to the success of a college-wide initiative to integrate computers into the curriculum, college leadership must demonstrate its commitment to the program by supporting it with adequate resources. Key support includes easy access to a variety of hardware and software resources and finanical incentives or released time for those participating in training programs.

Organization. Three basic models for organizing instructional computing have been previously discussed: separate instructional and administrative computing, combined administrative and instructional computing, and distributed instructional computing. The structure by which instructional computing is organized can influence the organization of the staff development program necessary to support it.

The decision to centralize staff development for instructional computing provides increased opportunity to coordinate resources, determine priority training needs, and monitor the speed of implementation. The decision to distribute the responsibility among various units—or to leave it up to individual faculty and staff—will likely lead to scattered and uncoordinated learning and implementation of instructional computing.

On the other hand, a distributed approach gives the faculty more freedom to explore different ideas and technology without the constraints of institutional priorities. A danger of leaving development activities up to individual faculty and staff is that this decision may be interpreted as a lack of institutional commitment to instructional computing.

Integrated or Special Status. Instructional computing can be integrated into ongoing staff development programs. This can signal the acceptance of the activity into the mainstream of the institution and provide staff training for computing in the less threatening context of more traditional professional developmental activities. Also, the new thrust can take advantage of existing mechanisms for coordination and dissemination.

By giving instructional computing a special status, the college can focus attention on related activities and results. This may indicate an increased college commitment and raise the expectations of the faculty as to the type of training, the availability of hardware and software, and the level of support available following training.

Setting Training Priorities

Training priorities can be established in a number of ways. They can be based on the resources available, on the knowledge and skills of the trainers available, on the needs articulated by the faculty, the short-term needs of the institution, the concreteness of the development plans of individuals or departments, the subject area , the amount of time required for training, the complexity of the training, and the knowledge level of the faculty to be trained.

Some questions of priorities that may arise include: Should technical disciplines receive priority for training over non-technical disciplines? Should initial training be concentrated on bringing all faculty to a basic level of competence or on assisting those most ready to use computers in instruction? Should training that provides immediate results be favored over that which provides long-term development? The process used to establish priorities and how the process is communicated to key faculty and staff will affect the acceptance of instructional computing in the college.

Determining Target Groups. Decisions will be required to determine the target group upon which to focus training efforts and resources. This is much like deciding at which level to teach in any class. If the institution is committed to providing training to all staff at various levels, group training sessions will need to be supplemented by materials and staff assistance to support individualized learning.

A comprehensive program would include group training sessions in basic computer literacy and common software applications; specialized training—either on or off campus—for those with special needs or with advanced skills; individualized sessions and staff assistance; and ready access to hardware, software, and staff resources through a centralized location, such as a faculty resource and training center.

In as much as possible, staff development activities should be provided to all interested staff. However, if resources limit a comprehensive approach, criteria need to be developed to select staff to receive priority training. These may include criteria other than interest and should accommodate differences in approach that may occur among faculty attempting to integrate computing into the curriculum.

Adjunct Faculty. Related to these decisions is the special case of adjunct faculty. Decisions will need to be made regarding the availability of training for this important group. Expectations regarding the competence of adjunct faculty with respect to basic computing skills and applications associated with their disciplines need to be articulated, particularly if this basic competency becomes a norm for hiring adjunct faculty.

Determining Levels of Training. The level of training provided to faculty can be a single, common level that includes such elements as introductory computer literacy, introduction to word processing, spreadsheets, databases, and graphics, or it can be in progressive stages.

An institution may decide to support the development of staff to a specified level of knowledge or to develop a multi-level faculty knowledge of instructional computing. The latter will put some strains on coordinating a training program, but it can provide a rich environment and the possibility of peer coaching, teaching, and problem-solving. The transference of ideas from one discipline to another can flourish in this environment. Expectations for learning and implementation should take these differences into account.

Decisions on the levels of training available will be influenced by the trainers' abilities, hardware and software availability, subject area specializations, curricular needs, user requests and degrees of risk staff are prepared to take.

Development of Training Materials. The implementation of instructional computing and the training of faculty could be coordinated by standardizing on commonly available software and training packages, unless the college is prepared to commit resources to the preparation or adaptation of other materials. Using existing material may make the training implementation faster, but the material may not be customized to the subject or the needs of the learner.

Instruction on how to integrate software into the existing curriculum and how to make the necessary curricular changes based on that integration may require the development of training materials if

these cannot be obtained elsewhere. In addition, access to training should be available to faculty for all commercially obtained instructional software in their areas.

Self-Directed Learning. The fact that many faculty are accomplished self-directed learners should not be overlooked nor denigrated. Some faculty need the opportunity and support to learn on their own, particularly if their needs are highly specialized. Not all training is most effectively done in groups or using prescribed materials, and support and acknowledgment need to be provided for self-directed learning.

Follow-up Training and Support

As with all learning, the implementation and use of the knowledge gained will be directly related to the support and opportunity to use the knowledge. Faculty who have been encouraged to participate in training but who then do not have the resources necessary to apply their new skills will quickly lose them and their motivation to use computers in instruction. Both technical and instructional design support needs to be available following training.

The form of the support will depend on institutional practices and intent. Support can be provided through the identification of people within the institution that are able to provide technical or instructional computing assistance on-site to the faculty. Support also can include provision of the opportunity for the faculty to continue learning through other sources. Individuals who become proficient in some aspect of instructional computing need to be recognized for this, and they may then be used as a trainer or coach for other faculty.

As the faculty become more comfortable with instructional computing resources, their demands for training and usage will become better articulated and more sophisticated. Post-training support has direct budget implications. If a college is unwilling or unable to identify sufficient follow-up funding, its initial investment in training may be lost.

Using Innovators

Faculty who have learned to implement instructional computing resources can be very excited about the process and the results. This enthusiasm can be harnessed so as to multiply its effect within the institution. These individuals can be used as mentors, trainers, and workshop presenters.

To stimulate innovation, institutions should be prepared to recognize the professional contribution of innovators. Singling out innovations in instructional computing can stimulate others.

SECTION TWO: DEVELOPING AND IMPLEMENTING A PLAN FOR INSTRUCTIONAL COMPUTING

Chapter Six
Planning for Instructional Computing

Community colleges that have decided to integrate computers into their curricula need to develop and implement deliberate plans to accomplish this timely and important goal.

In the past decade, colleges have acquired considerable computer resources, and many have established solid technological bases upon which to build. However, institutions which have acquired computer resources pell-mell may be confronted with challenges to develop coherent strategies for using existing computer resources—much of which have already become obsolete or incompatible with developing industry standards.

Planning allows an institution to manage the growth of its computer resources, rather than having the growth itself determine the institution's direction and capabilities. This section provides guidelines for developing and implementing a plan for instructional computing that will allow a community college to accomplish the goal of integrating computers into its instructional processes.

The chapters that follow in this section are intended to provide a guide to assist a community college to develop and implement a plan for instructional computing. Chapters six, seven, and eight focus on developing a strategic plan for instructional computing, and the steps outlined are similar to those involved in most planning processes. Chapters nine, ten, and eleven are primarily concerned with steps necessary to implement the plan; they suggest ways to translate the goals that an institution may have for instructional computing into actual operations. First, some comments about planning are in order.

Planning Approaches

Planning for instructional computing involves the same general principles as planning to implement any change or innovation or to otherwise respond to important forces in the environment. The terminology of planning also applies equally well.

Planning is a process, and a plan is a result of that process, a periodic statement of where the planning process is at any given point. Peter Drucker describes planning as "the continual process of making decisions systematically and with the greatest knowledge of their futurity; organizing systematically the efforts needed to carry out these decisions; and measuring the results of these decisions against the expectations through organized systematic feedback." Planning is a dynamic process, but the actual plan is static, reflecting a point in time.

There are four general approaches to planning. All are workable, but the approach used should be compatible with an institution's established planning processes and its organizational culture.

The Top-Down Approach. This is most often used in institutions with a strong, centralized administration and organizational structure. In this approach, the planning direction and goals come from college administration.

The Bottom-Up Approach. A characteristic of this approach is the lack of specific planning guidelines from college leadership. Subordinates are asked to identify resources necessary to accomplish specific goals. The central administration consolidates the plans and makes the final decisions on the allocation of resources.

The Team Approach. The planning is done by a group of people chosen by the leadership of the college. Each member of this planning group provides input concerning his or her area of responsibility. This approach is commonly found in institutions with a decentralized administrative structure.

The Compromise Approach. In this approach, the administration provides general planning guidelines, which are then augmented by input from the planning group. This technique is a combination of characteristics of the bottom-up and team approaches.

With any of these methods, it is important to invite some level of participation from all areas that

will be affected. Instructional computing will affect all major college constituents, including faculty, staff, students, administrators, and even the local community. Effective planning will involve these groups in the process.

Strategic, Operational, and Resource Plans

The development and implementation of a plan for instructional computing can be usefully considered as a three-step process: the development of a strategic plan, the implementation of operational plans, and the allocation of necessary resources.

Strategic Planning. Strategic planning involves a comprehensive assessment of where an institution is and what it hopes to become as a result of planned effort. The principal components of a strategic plan include a scan of the external environment for forces and trends that will affect the institution's plans; a comprehensive examination of the internal institutional environment, including its stated missions, climate, and resources; an assessment of institutional and program needs; and a determination of both long-range and short-range goals and objectives for the institution.

Operational Planning. Operational planning involves the detailed organization of the components necessary to implement the goals and objectives set by the strategic plan. Such planning is primarily concerned with specifying the resources, facilities, training, technical support, and other elements required to accomplish these goals. Operational plans are usually detailed down to the project level; an operational plan for an institution will be composed of many discrete project plans that detail the specific steps necessary to implement well-defined projects within the context of the college's operating policies and procedures.

Resource Allocation. Ultimately, strategic and operational plans depend upon the allocation of required resources. Most colleges have well-defined processes for resource allocation, and none will be suggested here. However, the importance of the relationship among the plans charting the directions in which an institution wishes to go, the goals it hopes to accomplish, and the processes used to fund those plans cannot be overstated.

Preparing a Planning Manual

Once an approach to planning is determined, preparations need to be made to plan. A helpful initial step is to create a planning manual. This document can be used to provide a broad rationale for the importance of planning and the goals to be achieved by engaging in the process, as well as a guide to the steps to be undertaken. The manual can also provide an overview of the issues that may affect the planning process. It is a communications tool used to help organize the planning process and get all participants moving in the same direction.

The planning manual should outline the tasks that need to be performed to create a plan for instructional computing, stating who will do what and when. Assignments to obtain certain information or to perform discrete tasks can be made to a department or position. This helps fix responsibility for specific participation in the planning process without the need to immediately assign a specific individual.

A definition of planning terms should also be included in the planning manual. While the use of technical jargon should be limited whenever possible, it is sometimes impossible to exclude technical terms completely. These should be defined in the planning manual.

It is helpful to include in the planning manual statements of support from the CEO and academic vice president or other appropriate college leaders. Other levels of the institution will more readily buy into the process if there is a strong statement of commitment from key individuals. In any case, the importance of the explicit support of the CEO cannot be overstated.

The planning manual should also contain a general statement about the institution's goals and objectives for instructional computing, as well as what is expected to be accomplished in the planning process. Finally, a list of issues that may have future impact on instructional computing at the institution should be included. Such a list can anticipate circumstances that may arise as the planning process unfolds.

Developing a Strategic Plan for Instructional Computing

A plan focused on instructional computing should contain many of the same components included in strategic plans developed for other purposes.

Assessment of the Institutional Environment. A strategic plan should include a summary of the

institutional setting and an assessment of the institution's position with respect to instructional computing at the onset of the planning process.

First, the basic characteristics of the institution should be profiled: its mission should be stated; its pertinent history reviewed; the characteristics of its community briefly described; and the demographics of its students, faculty, and staff summarized. Also, the organization structure of the college should be delineated; the names and sizes of its academic divisions and programs enumerated; and its general operating and instructional budgets specified.

Also, any characteristics of its service area or programs that have special implications for instructional computing should be described. This may include a summary of current computing resources and capacity, as well as a review of previous and current experiences with using computers in instruction.

Needs, Goals, and Objectives. A strategic plan for instructional computing should also include a comprehensive assessment of academic program needs. This assessment should begin with an inventory of current needs. Then, all academic units and various support and advisory functions should be surveyed to identify their computing needs. Instructional program needs should be delineated by academic division, program, and discipline.

A critical element of the strategic plan is a statement of the institution's long and short-range goals and objectives for instructional computing. There are a number of effective ways to collect and distill the goals and objectives of different constituents, and the approach should follow established processess for reaching consensus about important issues with college-wide impact. Developing goals and objectives for instructional computing, however, should be accomplished in conjunction with a careful review of applicable institutional goals and objectives that have been developed as a result of college planning processes. A review and summary of pertinent parts of college master plans, long-range plans, facilities plans, and other strategic plans need to inform the development of a plan for instructional computing.

In general, long-range goals should target a five-year span; short-range objectives should be concerned with the next fiscal or academic year. Short-range objectives should be very specific to ensure that proper resources can be allocated. These short-range goals become project plans to be acted upon by those charged with designing and implementing the operational plan.

Planning for Implementation

In addition to the elements generally found in most strategic plans, a plan for instructional computing should consider other aspects of college operations that are more specifically related to the distinctiveness of the task. Because using computers in instruction is a relatively new phenomenon in most community colleges, and because such use has the potential to change fundamentally the ways that faculty teach and students learn, an instructional computing plan must consider the ways in which the college is organized to support instructional computing. Also, plans must be made for facilities, equipment, and staffing needed to implement computing throughout the college's curriculum.

Organizing to Support Instructional Computing. To support instructional computing college-wide, it is necessary to organize a variety of support functions. These include faculty support groups, software support groups, and hardware support groups. Issues of standardization, faculty development, and access are related to such support. In addition, decisions need to be made about the best ways to support networks, communications, and other services to various groups.

Planning Facilities to Support Instructional Computing. Resources such as facilities, equipment, and staff need to be planned considering the special requirements of using computers in instruction. An instructional computing plan should also address the coordination of computing resources in order to maximize their effectiveness in achieving instructional computing objectives.

Implementing Plans

Project plans need to be developed and implemented to operationalize the goals and objectives of the strategic plan for instructional computing. Such plans translate the objectives of strategic planning into specific projects that are implemented within the context of institutional operations and instructional practices. As specifically as possible, a project plan should identify the activities to be undertaken, the resources and support required for the activities, the anticipated outcomes of project, evaluation, and a timeline for project activities and completion.

Finally, project plans provide the specificity required to allocate resources. While there are variations among community colleges in the ways in which budget and resource allocation processes are conducted, in most cases, budgets can be built and resources allocated by accumulating the resources required by individual projects and determining the level of funding necessary to provide necessary support and related resources for the overall instructional computing plan.

A Word About Flexibility

The following chapters discuss these components of instructional computing plans in more detail. The purpose is to provide a guide for the development and implementation of such a plan. However, planning is a complex process. This guide attempts to provide discussion of as many of the issues as possible and to offer insights from experience while allowing for the fact that the particulars must be left up to each institution.

A word is also in order about the need for flexibility over time. As colleges plan to use computers to improve teaching and learning, many unforeseen changes will occur. Some of these changes will cause rippling effects, such as a gradual increase in the demand for technological tools. However, it is possible that curriculum content, delivery systems, and communications will be fundamentally transformed. Plans must be flexible to accommodate both gradual and transforming changes.

Since change is the norm, planning must provide for flexibility within a changing structure. For example, the needs and requirements for graduates keep changing; therefore, the faculty, curriculum, and resources also need to change. The challenge for educational planners is to provide an environment that enables and supports the teaching and learning act within changing scenarios.

Chapter Seven
Assessing the Institutional Environment

Reviewing the Institutional Mission

Building a plan for instructional computing begins with a review of the institutional mission statement.

Most institutional mission statements are broad statements that are modified only periodically. Given the age of many of the nation's two-year colleges, this cornerstone of the institution may be silent on the relationship between computing and instruction. Should this be the case, planners can approach the relationship of instructional computing to the overriding purposes of the institution from two perspectives that are not mutually exclusive.

One approach is to identify the stated missions of the college that can be explicitly supported by integrating computers into instruction. By specifying the ways in which the fundamental teaching and service missions of the college can be enhanced by the introduction or expansion of computer use, the college's mission statement can become a rationale for instructional computing.

Another approach is to acknowledge that even fundamental statements that reflect the core values of an institution such as missions should be updated to reflect changes in the environment. As community colleges respond to changing conditions, they periodically update their mission statements.

A signal of the commitment of the leadership of a college to instructional computing can be its willingness to modify the college's statement of mission to reflect that commitment. Such a statement should be a broad commitment that can withstand continual developments in technology and should not indicate commitments to specific technologies or projects. An example mission statement might read: "To provide comprehensive information technology resources to support both academic and administrative needs."

The symbolic importance of incorporating the goals of instructional computing into the college mission statement can translate into specific and consistent support for this major undertaking.

Assessing the Institutional Environment

If the college has routinely engaged in planning, a description of the institution, its constituents, its external environment, and its predicted future will generally be summarized in a series of general planning assumptions. These include the demographic trends anticipated to affect the student body and faculty, as well as sources of competition, workforce requirements, and projected levels of funding, all of which have important implications for instructional computing.

A strategic plan for instructional computing should review such data and assumptions and incorporate them into the planning process. If these are not readily available from a research or planning function, it may be necessary to engage in this important level of planning first. There are volumes of materials to inform such planning, and those resources will not be summarized here. Rather suggestions for assessing the institutional environment with respect to trends affecting instructional computing are provided.

The Environment for Instructional Computing

The current environment for instructional computing on a campus is the sum total of how technology is being used in support of the teaching-learning act. Technology is broadly defined, including generic tools such as hand-held calculators, computers, and video computer projectors; discipline-specific tools and software such as those used in CAD/CAM and electronics; and the skill-specialized tools of spreadsheets and word processing.

The teaching-learning act is the core of any educational institution. The four basic elements of the teaching-learning act are the teacher, the student, the curriculum, and resources. It is necessary to consider each of these interdependent elements in order to assess the current environment for

instructional computing.

A note of caution is in order, however. Assessing and determining the current status of the use of instructional technology on a campus is difficult because it keeps changing. The best approach is to put a stake in the ground. Determine the current situation, make plans based on that assessment, and ensure the plans remain flexible to adapt to the changing environment.

The following list of trends and questions related to each of the four basic elements of the teaching and learning act is provided to stimulate the planning process and an assessment of the institutional environment.

Most of the items receive more detailed consideration later. The observations enumerated under trends are in no way meant to be exhaustive. It is up to each college to decide which of these need to be addressed in its instructional computing plan.

***Faculty**—Trends*

- Faculty are gradually increasing their use of technological resources to support instruction.
- The percentage of faculty actually involved in technological growth and integration varies greatly—both between disciplines and within specific disciplines.
- Faculty generally begin experimenting with technology on a small scale, often due to pressure from students, peers, college leadership, or business relationship incentives.
- Use of technology often starts as an add-on to instructional programs. This approach emphasizes technology's use as a supplemental resource tool and not one that changes or transforms the way instruction occurs, its content, or student outcomes.
- Technology is becoming more powerful, reliable, and accessible. Thus, increased capabilities will be desirable and essential to meet growing requirements.
- There is no well-defined scenario for how faculty development for instructional computing takes place. Individuals respond differently, ranging from early visionaries to those who resist technology. One suggested scheme establishes four types of response to technological integration and change: innovators, early adaptors, consumer majority, and resisters. Individuals may move from one classification to another as they become more comfortable with technology.

***Faculty**—Questions*

- What kinds of training do faculty need to increase their technological capabilities?
- What kinds of training do faculty need to proceed through the process of experimentation, implementation and integration, and curriculum transformation?
- Where will this training be offered? Can existing training opportunities in the colleges be expanded or redirected?
- If each discipline will be implementing technology based on the requirements and opportunities specific to that discipline, where, when, and in what sequence should faculty be trained?
- What kinds of motivations and benefits can be offered to faculty for participating in technological development?
- What types of faculty should be hired? What kind of experience with technology should be required or encouraged?
- Should "centers of excellence" in various disciplines be established by community colleges to support faculty retraining?
- What local and national resources and opportunities are available to teachers? Should personnel exchanges with industry be encouraged or increased?
- Which faculty, if any, have the greatest impact on the total curriculum? Are there key areas, such as the communication or technical fields, that have the greatest impact based on predictable ripple effects?
- What types of tools are available to help teachers manage their classrooms? Tools to be considered might include those that facilitate the development of test item banks, test generation, test scoring, assignment tracking, scoring of homework, management of the varying needs of students, student progress management, and management of the available educational resources.

***Students**—Trends*

- Students entering the community college today are more diverse in terms of age, skills, previous experience, goals, and needs than ever before.
- Expectations and requirements for students' skills and their ability to contribute in an economic environment continue to increase. Basic skills, in addition to reading, writing and math, include: cognitive skills, such as learning skills, problem-solving skills, analysis skills, and synthesis skills; interpersonal skills, such as the abilities to lead, manage, and contribute as part of a team; and communication skills, including discussion skills, meeting skills, and presentation skills.

- Students' expectations in the area of retraining for specific jobs and positions will increase.
- Program counseling and assessment to determine the most efficient and effective way to complete a program will increase.
- Technological tools must be accessible to all students and faculty. Convenience of access, costs of access, and power of access will all be important issues to consider. Before a program or curriculum can be integrated technologically, a critical mass of technology needs to be available.
- Students must learn more content and develop more skills in less time than ever before. The faculty and curricula must adapt to meet these new requirements.

Students—*Questions*

- How can the community colleges deal with the tremendous diversity of students' needs, skills, learning styles, backgrounds, and objectives?
- How will materials for student individualization be developed and implemented?
- How will the students learn the technological skills needed for the use of the new technology and new curricula?
- How will students acquire fairly expensive technological tools?
- How will the transition to integrated technological courses be managed?
- How will student outcomes differ in the new curricula?
- How will students respond to a new learning environment which requires higher student participation, control, decision-making, and teamwork?

Curriculum—*Trends*

- Curriculum requirements for instructional computing are simultaneously becoming more broad and more specialized. Curricula are expanding due to information explosion, yet more specialized knowledge is required for focused training programs.
- Technological tools are "enablers" that will make it possible to offer a skill-focused curriculum.
- Expectations as to the amount of technological content in the curriculum are increasing. Some current curricula are criticized for being unaccountable, ineffective, inefficient, or combinations of these.
- In the past, curricula were expected to be agents for social change, including the integration of races and minorities. They are now expected to be agents for economic revitalization and global competitiveness by producing highly trained, educated, technologically competent graduates. The trend in specialized areas is toward specificity of curricula for job placement and economic success.
- New requirements are being proposed for high school curricula, for example, the James Madison High/Model High School Curriculum. Technological integration of some curricula is already occurring, for instance, word processing in writing instruction, spreadsheets in business and finance, and computer-assisted instruction in many different subjects.
- Software for existing curricula is rapidly being created, yet software is even more critically needed for developing areas of skill-oriented curricula.
- The curricula of community colleges must serve an increasingly wide variety of students and needs. Demands for technological tools to support all curricula are increasing.
- Groups and consortia are forming to develop new advanced-content curricula in math and sciences that will incorporate some of the latest technological approaches.

Curriculum—*Questions*

- Which curricula are the most advanced in its implementation of technological tools and capabilities?
- Some common curriculum areas, such as math and English, touch all students. Should these be changed? If so, how, and who will do it?
- There are significant curricula and program implications in the integration of technological tools in the common curricula areas such as math and English. How can these tools increase faculty and student efficiency so that the entire base of the curriculum is strengthened?
- What are the roles of professional societies and college and national boards in the revision of the curricula? Are student outcomes and skills specific, yet broad enough to be used as benchmarks for success and planning? Can they be?
- Which curricula in the institution are generic? Which are specialized? Should the college offer all the specialized courses or rely on other institutions to develop areas of specialty?
- Which programs have the most beneficial impact on the student body?
- Which programs have the most advanced technological needs and resources? How quickly will these needs grow?
- Are there local or regional resources for technological expertise or joint efforts?
- How will the developing capabilities of

telecommunications affect the programs that any one community college can offer and develop?

- How will telecommunications capabilities change the way students, teachers, and resources interact?

***Resources**—Trends*

- Technology is becoming more powerful.
- Technology is becoming cheaper.
- Technology is becoming more understandable.
- Technology is being applied in more disciplines.
- More software is being written and adapted for educational uses.
- Computer applications in the curriculum are becoming more sophisticated.

***Resources**—Questions*

- How can budgets be increased to cover new technology?
- How close to the leading edge of technology should community colleges be? Should this college be on that leading edge?
- How can the college keep its internal technical training current without large investments in staff development?
- How wide a diversity in software and hardware resources should the college support?
- Should resources be centralized for economy or decentralized for convenience?
- Should hardware and software standards be set? If so, at what stage of computer integration and level of use?
- Who determines resource connectivity?
- Should the college write its own software, purchase it, or both?

Chapter Eight
Determining Needs, Goals, and Objectives

After determining the conditions in the environment, a critical step in planning for instructional computing is to determine the needs that students, faculty, and the institution overall have for instructional computing and then, based upon the assessment of need, to identify the goals and objectives the institution has with respect to instructional computing. This is the heart of the planning process, for the goals and objectives identified become the catalyst for implementing projects that operationalize the plan.

Conducting a Needs Assessment

The principal concern of a needs assessment is to determine the skills that students must have to succeed in an increasingly competitive environment. In addition, the needs that faculty have in order to provide the best possible instruction to assist students meet their learning objectives must be identified. The task of identifying needs—and in separating needs from wishes—can be approached from a number of perspectives.

Student Needs. The skills required of students to succeed in an increasingly technological and competitive work force can be determined with assistance from representatives of local business and industry. Advisory committees for occupational programs often have members closely in tune with the demands of the current workplace. In addition, surveys of employers of completers of college programs can assess student skills and identify areas that need to be strengthened, particularly with respect to computing competence. An institutional research office can assist the assessment of need by surveying the business and industry community concerning their perceived needs and their evaluation of the preparation of college graduates.

Equally important is the collective wisdom of faculty and academic leadership concerning the skills that students should have to be successful in academic studies, workplace performance, and responsible citizenship. These skills are usually specified in terms of degree requirements and competencies required for program completion. Such requirements need to be reviewed and updated regularly, and they should address issues of student computer literacy in very specific terms. These become benchmarks to assess resource requirements to achieve specified levels of student skills.

Faculty Needs. Faculty needs should be considered in terms of the skills and resources they require to assist students to achieve their learning objectives. Faculty teach in their roles as subject matter and pedagogical experts. As the methodology of instruction is affected by technology, faculty need to develop the competence to use technological resources effectively in the classroom. Faculty needs for training and teaching resources can then be identified.

Determining faculty needs is a complex process that relies on faculty themselves to identify their need for training and to request appropriate computer resources to facilitate their instructional practices. While there can be no substitute for the input of professional faculty, some care must be taken to separate needs from wishes. Faculty requests for resources should be stated in terms of student learning objectives.

Program Evaluation. The routine processes that institutions have developed to evaluate college programs can be invaluable in determining program needs. This evaluation provides important program information, such as the number of student majors, the number of students enrolled in courses offered by the program, the number of program completers, the number of full and part-time faculty, and trends for all of these and other variables. Program evaluation provides a context in which to evaluate requests for resources, as well as a catalyst to identify weaknesses that might be addressed by the addition of technological resources.

Inventory of Existing Resources. Assessing needs should also include a comprehensive inventory of the resources that the college already possesses that can be applied to assist faculty teach and students learn. Such a inventory should catalog not only current computer resources, such as the number and type of computers and applications and instructional software packages, but also other supporting

resources, including technical staff, programming support, related media and library resources, mainframe computing capacity, faculty and staff expertise, training materials, and other resources that can support instructional computing. An institution should also carefully assess the ways in which it is currently using computers in instruction so that it can plan to meet projected needs from the basis of current capabilities.

Needs Identified. A comprehensive needs assessment should result in the identification of instructional needs at the academic division and program level. Program needs should specify the level of student access to computer resources that must be provided to meet student needs. In turn, these requirements can be translated into extremely concrete terms, for instance, the number of student workstations required to fulfill a particular program requirement.

The needs identified in such an assessment provide the basis for identifying goals and objectives, and the starting point for project and operational plans.

Identifying Long-Range Goals

A critical element of an institution's plan are the long-range goals it establishes for instructional computing. These goals serve as guideposts to check annual accomplishments and to evaluate progess along the way. Long-range goals also reflect an institution's best guess of the forces that will shape its future and its hopes for what it can accomplish. Long-range goals are those that an institution sets for itself for three to five years.

Once again, the four essential areas of the teaching-learning act—faculty, students, curriculum, and resources—provide a framework in which to ask important questions regarding an institution's long-range objectives for instructional computing.

Faculty. Faculty will implement the mission, goals, and objectives of the institution with respect to instructional computing. An institution must consider the environment which it hopes to provide faculty; it must also consider its expectations regarding faculty attitudes, skills, and performance.

- What computer skills will be required of all faculty?
- What minimum level of computer knowledge will be required of new faculty as a basic qualification for hiring?
- Will expectations regarding faculty computer skills differ by discipline?
- Will "lead innovators" be appointed (formally or informally) to develop prototypes for instructional computing resources in a discipline while other faculty assist in the implementation?
- Will rewards be structured to encourage competence and innovation in instructional computing?

Students. Students are both the consumers and the products of postsecondary education. While the long-range goals of an institution should focus on the knowledge and skills it aspires to provide its students, some consideration should also be paid to the kinds of students the institution hopes to attract.

- What are the size and characteristics of the pool of students from which the institution draws its enrollments?
- What share of that pool does the institution expect?
- What kinds of students will be attracted to the college after it has integrated computing into its curriculum?
- What knowledge and skills does the college hope to assure in all of its graduates?
- For what opportunities after program completion does the college hope to prepare its students?
- How will the college respond to its responsibility to provide skilled graduates to meet the workforce requirements of the local business and industry community?

Curriculum. Certain issues need to be resolved to develop long-range objectives for the curriculum.

- Does the institution aspire to implement the concept of computing across the curriculum?
- If the plan calls for computing to be implemented across the curriculum, will computers be used in every course? If not, what are the criteria for determining which courses will use computers?
- When will the incorporation of instructional computing into a course be considered a curriculum change, and how will such changes be approved in the college's curriculum processes?
- How will a focus on computing in instruction affect the principal goals of the college's curriculum?
- How will changes in the curriculum affect articulation with the curricula of the secondary schools from which the students enter the college and the four-year colleges and universities to which they transfer?

Instructional Computing Resources. Trying to predict the nature of instructional computing resources available to a college in three to five years is an enormously difficult task. The only certain trend in instructional computing is that the rate of change will continue to accelerate. Major changes in hardware and software are on the horizon, and these changes will bring much more sophisticated computing environments at drastically reduced prices.

The basic questions that planners need to ask are quite straightforward, though planners should also attempt to consider the future of specific elements, namely hardware, software, networks and communications, resource centers, and personnel.

- How will the institution benefit from the changes?
- What will the institution do with its current environments?
- How much are these changes going to cost?

Hardware. Extremely sophisticated hardware environments are now available and will be much less expensive than instructional computing resources that were acquired in the past. The main challenge for higher education institutions is to pick the environment in which they will be willing to operate three to five years from now. Some questions that must be answered are the following:

- What workstations will be available in three to five years?
- What aspirations does the college have to remain current? What aspirations can it fund?
- If the institution expects to upgrade its hardware to take advantage of changes in the computing environment, when will new equipment acquisitions begin to reflect the change in policy?
- When are the bulk of the current instructional computing resources slated for replacement?

Software. There are also major changes on the horizon for software environments, improvements that will finally allow applications developers to tap the potentials of the current hardware. The biggest immediate change will be in operating systems. This change will allow for increased use of simulations, which are likely to be revolutionary for higher education, as well as for many other new applications.

Another concern is that once operating systems change, applications software generally need to be changed to operate on the new systems. This will be very expensive. The real challenge is to develop timelines to implement changes based on the unique situations of each specific institution. It is not a matter of if an institution will respond to changes in technology; it is a question of when.

- What software operating systems will be in primary use in the local business community in three to five years?
- Will the college be forced to change the software on which it provides training to reflect business use or to take advantage of advances in technology?
- What use will the college have for software resources currently available?
- Will the college's hardware environment support multiple software standards?
- What is a reasonable and affordable schedule for the college to upgrade its software resources?

Networks/Communication. The data communication network should be thought of as part of the basic infrastructure of the institution. It is analogous to streets in a city. There is no substitute for good planning and design. The communications network should be well-planned so that the inter-connection of all computing resources can be made affordable.

- In five years, what resources does the college expect to have connected by networks?
- What type of networks best suit the instructional computing environment, college operating procedures, and the climate and culture of the institution?
- What will the physical characteristics and capabilities of networks be in three to five years?
- Which external resources does the college plan to utilize through its communications capabilities?
- Does the college intend to project its instructional program to remote sites using its communications capabilities?

Resource Centers (Labs and Training). A difficult issue in planning for instructional computing is computer lab resources.

- Should labs be added in a block?
- Should existing labs be expanded based on some projected usage equation? If so, what is that equation?
- Should labs be discipline-specific or general-purpose?
- Will large labs be broken into discipline-specific labs when demand increases?
- Will special facilities be available for faculty and staff training, as well as for their general use?

Personnel. Decisions about hardware, software, communications, and resource centers will affect the

type of personnel that will be required in the future in order to integrate instructional computing resources into the curriculum. Human resources must be part of the instructional computing plan at the institution.

- What level of staffing will be required to support instructional computing at the college?
- What qualifications will be required?
- From where will the college recruit qualified applicants? Will the college draw upon its pool of graduates as employees?
- What level of support can be provided by students?

Short-Range Objectives

Once the long-term goals for instructional computing are established, specific short-range objectives covering from one to two years can be outlined. These objectives are then developed into specific projects and implemented as part of the operational component of the instructional computing plan. The short-range nature of these objectives provides a direct tie to the resource allocation process, which at most colleges, funds projects for one or two years.

Short-range objectives must be specific and measurable. They must indicate the person, persons, or units responsible for conducting activities that lead to the accomplishment of definable outcomes. Short-range objectives should identify as much as possible about who is going to do what, when it is going to be done, and how one will know when it has been accomplished. Short-range objectives for instructional computing are much like the behavioral objectives that teachers set for their students.

Short-range objectives are the final piece of the strategic plan that provides the specificity necessary to assign tasks, allocate resources, and implement the plan. Specific implementation steps will be detailed in operational plans. However, all of the issues that affect these objectives should be resolved as part of the strategic planning process.

Review of Institutional Goals and Objectives

It is important to recognize that developing goals for instructional computing must take place within the context of other college planning processes. Most colleges will have engaged in planning and will have established long-range and short-range goals and objectives for the institution as a whole. Only some of these will relate to instruction, and fewer to instructional computing.

However, it is important to review institutional plans, goals, and objectives while developing these specifically for instructional computing. In many cases, the institution's aspirations for itself will be congruent with goals related to instructional computing. In other cases, it may be necessary to reconcile previously stated goals with changing technology and environmental conditions.

Chapter Nine
Organizing Support for Instructional Computing

After developing a strategic plan for instructional computing, the remaining challenge is to implement its goals and objectives. Implementing the plan requires the organization of support mechanisms for instructional computing, and colleges without a long history of using computers in instruction will probably be required to develop new structures to support instructional computing effectively. In nearly all institutions, the decision to use computers in instruction will substantially affect the institution's organizational structure—particularly if its goals are ambitious and cut across academic disciplines and divisions.

In general, community colleges will need to develop specific structures to provide faculty with the training, hardware, software, and technical support necessary for them to implement computers in their classrooms. They will also need to make difficult decisions regarding hardware and software standardization and resource coordination in order to maximize the benefit obtained from available resources. These issues are discussed in this and following chapters.

Organizing to Support Computing

A major prerequisite for integrating computing into the curriculum is to put in place an organization charged with the responsibility to provide support and coordination for all computer applications according to the college's instructional computing plan.

Centralized Support Function. If the goal of the college is to achieve a unified, consistent direction within limited budget constraints, responsibility should be assigned to a single entity to assure that all efforts and funding are coordinated according to the college plan. There are many advantages in placing this responsibility with one group so that a consistent driving force can be maintained in all phases of academic computer implementation in the organization. A major reason is to identify clearly those responsible to support the efforts of faculty and others to integrate computing into instruction in their disciplines.

As has been previously discussed, there are three basic ways by which a college might organize its overall computing services: maintaining separate structures for administrative and instructional computing, combining the two functions, or distributing the functions throughout the organization. How a college organizes its computer services will obviously affect how best to provide central coordination for instructional computing. Nonetheless, the key is to assign the function unambiguously and to communicate the assignment to all who will be affected by the attempt to integrate computing into the curriculum.

Steering Committee for Academic Computing. Regardless of the structure selected, a steering committee for academic computing should be organized to provide a forum for the discussion of issues related to implementing instructional computing and to set priorities for the multitude of tasks that must be accomplished institution-wide. This committee should be advisory to the entity assigned the centralized support function and should be composed of those most affected by computers in their areas, such as the academic and vocational deans, administrative and academic computing directors, other program directors with responsibility for academic computing personnel, and key faculty from across the college.

Also, many smaller groups will be needed to fulfill the objectives of an instructional computing resource plan, including a faculty support group and software and hardware support groups. The steering committee will provide important feedback and direction for the effective operation of these support groups.

Organizing Faculty Support

The instructional computing plan will be used by administration, faculty, and other staff to implement computers in their respective areas. In addition to the guidance provided by the plan, these groups need additional support to accomplish tasks. Such support services need to be incorporated into the plan.

Services should be provided that include:

- Training: general computer literacy; computers as a tool in education; software applications packages; programming and authoring languages.
- Consulting: computer applications; mainframe applications; procurement of hardware; procurement of software; needs of the academic users; availability; advantages and disadvantages of software packages.
- Library: periodicals; software and hardware sources; software packages; training materials.
- Equipment Availability: loan; purchase, including faculty discount plans.
- Printing: text; graphics; desktop publishing.
- Other: communications packages; test generators; grade book programs; other academic packages.

Organizing a Faculty Support Group

A faculty support group can play an important role in gaining acceptance for computing applications in instruction and providing key support functions. Such a group can be primarily responsible for providing technical support to departments/faculty in their development of curricular applications of computer-assisted instruction and computer-managed instruction. This group could also provide the training workshops for faculty in computer literacy and software applications.

The following functions can be performed by a faculty support group to assist the objectives of the instructional computing plan:

- Provide assistance to the faculty and staff in using computers in their respective areas.
- Counsel faculty in determining computer needs and resources.
- Advise faculty and staff on computer hardware needs.
- Assist faculty to evaluate software packages.
- Provide consulting information to staff concerning computer use throughout the institution.
- Promote and encourage computer use throughout the institution.
- Attend professional seminars and conferences to keep abreast of changes in educational and computing fields.
- Visit other schools and industry sites to evaluate their procedures and plans for using computers in education.
- Provide assistance for the faculty and staff in implementing computer management of instruction in their respective areas.
- Assist in establishing computerized test banks.
- Provide a resource person for determining availability of software packages.
- Provide up-to-date information about software and hardware vendors and their products.
- Promote and encourage faculty involvement with computers in the institution.
- Provide seminars, workshops, and training sessions for faculty literacy.

Access and Training. There is no substitute for providing faculty with access to computers and training in their use. These need to be keystones of any support provided to faculty to assist them to integrate computers into their instructional practices.

Faculty access to computer resources is a very important ingredient in faculty acceptance of computers in the curriculum. Initially, computers should be placed in faculty offices or common areas to gain their attention and encourage experimentation with how this machine can help faculty on an individual basis. Later, as faculty interest accelerates, more machines can be made available in a common area maintained by a faculty support group.

Initially, informal workshops and seminars can be offered to faculty during the college day to promote computer usage throughout the institution. Early on, it is probably best to offer this training to those who show an interest in learning about computers with no reward other than the learning experience. Faculty can then return to their discipline areas to promote computer use in the classroom. Later, it may be necessary to provide released time or stipends to encourage all faculty to apply computers in their classrooms. In addition, grants can sometimes be obtained to provide faculty the time and resources to develop or implement instructional computing applications.

Workshops can also be provided to promote the use of computers in the management of classroom instruction and to show teachers how the computer can make their work loads easier. Faculty can determine for themselves how grade book routines, word processors, test generators, spreadsheets, databases, desktop publishing, and other software packages can drastically diminish the time spent in class preparation and class management.

Organizing Hardware and Software Support

Standardization. Before organizing groups to support hardware and software use, planners should consider carefully the issue of standardization. If the institution chooses to standardize hardware and software, selection must be made early. The advantages of standardization exceed those of allowing each department complete freedom to select their own systems, which could result in the rapid proliferation of equipment and incompatibilities between systems in the institution.

Most colleges will find it necessary to provide their own microcomputer maintenance, and thus it is necessary to select a hardware standard in order to stock spare parts, train and determine the experience of maintenance personnel, and provide training courses for computer users. In addition, software packages should be standardized to the maximum extent possible. This will allow for consistent training and compatibility of work transferred among departments.

It is recognized that great care must be exercised in setting college-wide standards. Faculty, in particular, are not usually in agreement with strict, inflexible standards that take away their right to choose their preferred technology freely. If policies are too restrictive, users will find other methods of meeting their individual needs. A much better approach is to consult and encourage users to do what is in the best interest of the college overall.

All the advantages of adhering to the college standard can be emphasized. Counseling and procurement assistance can be provided with the many advantages of standardization delineated. A discount plan can be established for the purchase of the hardware and software standards so that users can weigh the benefits of quality versus cost. Users can examine the hardware and software installed institution-wide with a knowledgeable person assigned to be the institution's sales representative who can point out the many advantages of purchasing the college standard.

Training on standard hardware and software can be provided by the academic computing support personnel, which would relieve the user of many responsibilities for maintenance service and preventative maintenance. A telephone help line can be maintained so user has rapid access to an "expert" in hardware and software problems. In general, users can expect comprehensive guidance and assistance in implementing computers to meet college goals.

Organizing a Software Support Group. A software support group is needed to provide coordination and support for college-wide software implementation. Phone consulting can be provided to assure rapid solutions to problems that users have with software. In addition, this group can be responsible for developing and presenting seminars and workshops in computer software applications. This group can provide research on new software packages and make recommendations to the academic computing steering committee for new institutional standards as the need arises. A software library should be maintained so faculty can examine the various applications packages to determine which ones best meet their needs. The following is a list of functions that might be performed by a software support group:

- Inventory all software needs for staff, faculty, and students.
- Determine which software packages will best meet the user needs most efficiently.
- Determine which locations in the institution will need constant availability of software packages.
- Designate a support person to be available to provide information and training on key software packages for faculty and staff.
- Establish a system for inventory maintenance and security.

Establish a Software Library. Another function of a software support group can be to establish a software library. The following functions should be performed:

- Maintain a file of all software in the institution.
- Provide check-out of software packages by staff for use in the institution.
- Provide check-out of software packages by students for use in labs.
- Maintain a current inventory to reflect actual usage of software in business and educational environments.
- Keep abreast of changes within the industry to provide information to those in the institution who need this service.
- Establish a modem link to allow access to on-line database services.

Organizing a Hardware Support Group. A hardware support group is needed to provide consulting to faculty about hardware to meet their academic

computing needs. This center should be responsible for troubleshooting, repair, and preventative maintenance for computers in laboratories and other college locations. As the need arises, fabrication and development of hardware can also be provided. A hardware support group might assume the following responsibilities:

- Provide assistance to faculty in developing specifications for hardware needs.
- Maintain supplies and spare parts for computer equipment maintenance.
- Provide routine preventative maintenance of equipment and supervise major repairs performed outside the institution.
- Repair computer equipment as time and resources allow.
- Upgrade equipment to the extent possible as technology changes.
- Maintain control of equipment.
- Continually strive to lower operating costs and expenses by evaluating current procedures.
- Coordinate procurement of computer hardware for institutional use.
- Evaluate new equipment and delivery systems.
- Fabricate hardware equipment to achieve maximum cost-saving and quality.

Coordinating Computer Resource Acquisition

Probably the key organizational issue that a college must address is how to coordinate hardware and software acquisition so as to maximize computer resources available to implement the instructional computing plan. There are a variety of options for guaranteeing coordinated acquisitions, though the most obvious is to delegate the authority for acquisitions to the same organizational entity charged to coordinate support for the instructional computing plan. An equally practical approach is to require the signature of the chief academic officer—or equivalent position—for the purchase of all hardware or software; then, a mechanism can be built into the approval process that the officer consult with the central instructional computing support function regarding all acquisitions.

However organized, the entity coordinating resource acquisition must maintain current knowledge of cost of hardware and software, including discount purchase plans and availability. The entity might also perform the following functions:

- Determine computer resources available and their possible applications at the college.
- Provide planning and administration for future computer uses institution-wide.
- Develop hardware and software specifications to provide control and standardization of computers throughout the institution.
- Provide information about the availability of the chosen standards.
- Consult in the procurement of hardware and software to achieve standardization.
- Coordinate policy decisions for computer use college-wide.
- Allocate and reallocate limited computer resources to obtain the objectives set by the college.
- Monitor program and computer operations to provide maximum utilization of resources at the lowest possible cost.
- Maintain inventory control of all computer equipment and software as assigned.

The organization of support functions and the coordination of resources are keys to accomplishing the goals established by the instructional computing plan. Without effective policies and procedures in these areas, plans are not likely to be translated into effective operations.

Organizing Communications Support

Communications comprise another very important area of support. Institutions should consider various forms of computer communication in their computing plans, including local area networks, college bulletin boards, desktop publishing, and other computer applications that will provide enhanced communications and information sharing.

Local Area Networks. LANs are computer support systems to allow computers to communicate, share programs, share data, and send electronic mail from office to office. These are only a few of the uses LAN systems facilitate. Networks are made up of individual stand-alone computers linked together by networking hardware, usually a special communications board mounted in each computer and a dedicated network server. Special software resides on the server that allows the other computers to share peripheral devices such as printers, hard drives, scanners, and plotters.

Educational uses of a LAN include enhanced ability to train students in software applications, programming, operating systems management,

networking installations, and file-sharing techniques. There are substantial cost advantages to networks. Most training software need only be bought once and may then be shared by everyone on the system. Site licenses for many applications software packages can be purchased to operate on networks less expensively than multiple individual copies.

Communication with Administration. The most obvious uses for computers are those tasks that are labor-intensive and repetitive. Every term, for example, classrooms and class schedules need to be correlated; a computer spreadsheet is an easy way to keep track of the classrooms and available times. Grade books can be eliminated by maintaining grades in databases. Storing grade data in computer files and calculating final grades using computer programs reduces human labor and error. The logical extension of using the computer as a grade book is to allow faculty to submit grades through computer networks. Submitting grades through networks eliminates time-consuming transcription and errors that can occur when grades are transferred toanother media.

A College Bulletin Board System. There should be an institution-wide network that allows for electronic mail, a bulletin board on at least a faculty-unit basis, and access to appropriate mainframe information, either from campus or home. Information that is usually printed, such as the college report and newsletters, as well as other less official information, can be disseminated in a more timely and inexpensive manner. Memos can also be sent via electronic mail among faculty and staff.

An electronic bulletin board can be implemented quickly and relatively cheaply. All faculty can be provided access to such institution-wide information services by the addition of a modem to available personal computers. Such access is especially important to acclimate faculty to the increased presence and use of computers on campus.

Desktop Publishing. Desktop publishing is another important way to enhance campus communications. Faculty and staff can customize documents to produce professional-quality documents in a minimal amount of time. Many departments in institutions now depend on printing services to produce their documents. This method requires at least a one-day turn-around time. Desktop publishing provides on-the-spot, customized printing. This can result in documents, including instructional materials, being printed in a more timely, cost-effective manner.

Chapter Ten
Planning Facilities to Support Instructional Computing

Implementing a plan for instructional computing may substantially affect a number of college operations and support services. Effects on organization structure, staff development programs, curriculum and budget processes, and purchasing processes have been discussed. Other support services will also be affected by an ambitious, college-wide effort to integrate computing into instructional practices, including instructional design services, graphics and printing services, library services, and selected student services. In most cases, planning will be required to provide for increased demand for these services.

However, nowhere will the effect of implementing of an instructional computing plan be greater than on the physical plant. Not only will new facilities have to be developed or existing facilities adapted to meet identified needs, but resources to staff and maintain these facilities will have to be provided.

This chapter focuses on facility development that may be required to support instructional computing.

Alternatives to Meet Facility Needs

Each college must decide whether its own planning objectives may best be met by building a new facility for instructional computing services or by installing computers for this purpose in an existing facility. Current resources and projected growth plans will affect this decision.

Institutions may choose to convert existing rooms throughout the campus into decentralized computer labs. Others may opt to construct a new computer center to serve instructional computing needs centrally—or to serve both administrative and instructional computing needs. The size, type, and number of facilities required will depend on how the college has resolved some of the organizational issues discussed earlier in this document.

A New Facility. Some institutions will be required to build a new facility to support instructional computing. Planning to construct a new building is the focus of this discussion. However, many of the following considerations also pertain on a smaller scale to modification of existing rooms and buildings.

Planning Expertise. Expert input is highly recommended in developing action plans for facility development. The project manager, consultants, vendors and appropriate specialists should coordinate their efforts in this phase to identify realistic goals for the institution. Regular meetings to evaluate project development should be held, and objectives re-formulated as necessary.

Timetable. The preparation of a timetable for facility development as part of the action plan may be helpful in evaluating progress. As appropriate, tentative dates for such activities as site selection, design, approval and permits; for zone application, hearings and approval; for RFP preparation, hearings and release; for bid selection and acceptance; for physical planning with vendors; and for relocation and installation planning should be scheduled. In some states, approval by appropriate state and local agencies is also required.

Construction of a new facility will require planning for site selection. Evaluation of a site should take into consideration its security from disasters, the availability of reliable and economical power sources, and the potential for future expansion if long-range objectives so dictate.

Physical Space. Planning and designing physical space will necessitate an inventory of any equipment currently on-hand, determination of projected growth, and creation of a layout plan. Minimum, maximum, and optimum space requirements for hardware, support areas, instructional areas, and office space need to be considered. Long-range objectives should address projected requirements for future expansion.

The design of the facility must allow sufficient area for the delivery or moving of equipment. This includes such considerations as halls and doorways of adequate width and elevators able to support the expected weight of the equipment.

Lighting and Acoustics. Physical planning decisions about lighting and acoustics will be required. Expert input from consultants or other specialists

can help assess needs in these two areas.

The quantity and type of lighting must be specified in the building plan, including task lighting for specific work functions. Acoustical treatment may be planned to provide a quiet environment in the instructional computing area. However, the benefit of providing such an environment for students, staff and faculty using the facility should be weighed against increased costs.

Floors. Equipment areas require a floor covering that will minimize or eliminate static electricity. The floor should be designed to help support the weight of the equipment. A raised floor will hide and protect power cables, lines and duct work and also provide for better air circulation beneath the equipment to assist in cooling.

Heating and Air Conditioning. If a building area designated for instructional computing already has a heating and air conditioning system in place, it is necessary to determine whether its capacity is adequate. Consultants may recommend modification, replacement, or the installation of a stand-alone system to meet the requirements of the equipment and personnel located within the area.

The physical comfort of faculty, staff and students using the facility should be provided for in the plan. Also, fluctuations in heat and humidity can damage computer resources; consequently, vendors may require a suitable environment to honor warranty and service agreements.

Electrical Requirements. Providing reliable and economical electrical power is an objective that must be addressed in the operational plan. Power requirements for computing resources can be large enough to be of budgetary concern. In addition, computer down-time is expensive and inconvenient, and an uninterruptable power source for emergency back-up is recommended if feasible. The electrical system should be thoroughly documented and should provide for growth adequate to meet future requirements.

Fire Extinguishing Systems. A fire extinguishing system is a requirement for any installation. Institutional needs can be determined in consultation with plant services personnel, risk managers, insurance carriers, fire department personnel, vendors, and auditors. A fire protection system may be as simple as the provision of hand-held fire extinguishers or as complex as a halon-based or water-based system. Local building codes should be referenced in making this decision.

Disaster-Recovery. A plan of action should be outlined to cope with data loss, equipment failure, and interruptions in providing resources to instructional computing needs. The impact of a computer resources failure on the institution, and whether it will be possible to continue instruction without these resources during the recovery process, should be assessed. Plans might include establishment of off-site storage for critical program and data files as a safeguard against fire, flood, and other disasters. Many insurance carriers provide plans for equipment replacement protection in the event of a disaster loss.

Protection Systems. Institutions may wish to plan for the installation of an access control system to protect computer data and limit access to selected areas. These systems are designed to control the flow of people through certain areas at certain times.

A security system designed to set off an alarm if an unauthorized entry has taken place may be a priority if protection is desired for computer rooms, labs, or other areas that house expensive equipment. Motion-detection systems and door-sensing devices are examples of such security systems. Machine security devices should be considered for securing small, portable, but expensive devices.

A notification system is another specialized alternative that should be considered in facility planning. This system is designed to notify appropriate personnel when the fire alert, water alert, or security systems detect a problem. A sophisticated internal security and environmental system includes this feature in its design.

Network Cabling. Vendors, consultants, and institution personnel can help define the specific requirements needed for a cabling plan. The current cabling system for the college network, if one exists, will be affected by additional requirements imposed by new computing resources. In addition, cabling needed for meeting long-range instructional computing objectives should be considered and thoroughly documented in the initial plan.

Site Coordination. Before finalizing the plan for facility construction or renovation, past audit reports should be reviewed and discussed with the auditor. This review may assist the college to avoid previously noted exceptions and develop appropriate procedures. Also, facilities planning activities should be coordinated with the building manager to insure the availability of staffing and financial resources necessary for building modifications.

Equipment to Support Computer Facilities

Furniture. Proper furnishing of the instructional computing facility with ergonomic furniture will significantly increase user comfort and reduce stress. Utilization of computing resources will be optimized if the needs of users are anticipated and addressed. Adjustable, fabric-covered chairs; adjustable workstations; ample storage facilities; and service counters and islands are recommended.

Computer Hardware. The computer hardware needs will be dictated by the particular objectives for the instructional computing facility and budgetary constraints. Technology, such as videodiscs, interactive systems, and multimedia systems, and other state-of-the-art equipment that is used to support the instructional program, should be incorporated into computing facilities whenever feasible.

Connectors and Cabling. If a new facility is being designed, there may be cost savings in combining data and phone cabling. In addition, the installation of cable that will meet future needs will usually be more cost effective, even if not used to its full potential. The cabling scheme should be documented completely.

Software and Supplies. Software decisions will often affect hardware selection. Therefore, both the cost of the software package and the cost of the hardware required to run it need to be considered in planning.

Additional supplies will be needed to support facilities development portions of the plan. These include such items as ribbons, paper, and printer and cleaning supplies.

Staffing Requirements

Creation or expansion of instructional computing facilities will require an assessment of current personnel resources within the institution and the need for additional staff. Available staff and faculty time should be assessed to determine optimum utilization of existing staff. Personnel requirements can often be met by reassigning available staff.

Hiring Issues. The specific requirements of new positions created by project planning should be identified. Vendors, consultants, and other institutions may be of assistance in developing job descriptions.

The advantages and disadvantages of employing full-time or part-time personnel and hiring or reassigning personnel should be considered. Reliability, turnover, flexibility, scheduling, supervision, experience, training, and costs are some factors to be examined. Fringe benefits for staff, generally 20 to 30 percent of salary, need to be included in planning project costs.

Faculty Released Time. Provision for faculty released time should be incorporated into the plan for meeting the objectives of instructional computing. Faculty can be used as resources in developing and implementing the project as a whole. The integration of instructional computing into the curriculum can require modifications to the existing curriculum that faculty members may need time to implement. Staff may also need released time for training in the use of hardware and software associated with the project.

Training and Technical Support

An assessment of the computer literacy levels of staff, faculty, and students affected by the project will help in identifying training and technical support needs. Vendors can provide information on hardware and software packages that will help meet these needs.

The means to provide the necessary training and technical support should be developed. A description of these needs regarding faculty, software, and hardware support has previously been discussed.

Hardware and software vendors may provide training with the purchase of their products, often at no additional cost. Technical support can be provided by upgrading the skills of existing personnel, hiring new personnel and/or contracting with an outside agency.

The specific requirements in terms of programming, maintenance, and personnel support needed on a continuing basis should be identified and addressed in the plan.

Maintenance Requirements

Detailed information on maintenance requirements for hardware and software is normally provided by suppliers. The requirements, which are often a condition of the warranty, should be examined in detail and incorporated into the action plan. Procedures should be defined for reporting and tracking maintenance problems and costs.

Vendors. Vendors generally provide on-site

maintenance for large systems. For microcomputers, vendors may also provide the option to carry or mail in equipment for replacement or repair. The options available and the cost of these options should be carefully noted. The time periods for maintenance, the minimum and maximum response time, and time and material rates need also to be considered. Vendors may protect maintenance prices through the fiscal year with a no-raise guarantee.

External Maintenance. It is important to check the maintenance provider's level of reliability and ability to respond in a reasonable amount of time. Maintenance may be performed on contract or on a time and material basis. If the maintenance is to be provided by multiple vendors, it is necessary to be aware that one vendor may be reluctant to cooperate with another. Where institutions decide to rely on external maintenance, they should consider designating an individual to diagnose simple problems and to coordinate the delivery and return of equipment needing repair and visits by maintenance technicians.

Internal Maintenance. Institutions may plan to provide internal maintenance using existing or new staff. In this case, the institution must provide appropriate equipment and parts inventory. The degree to which an institution standardizes on equipment will have a significant impact on the complexity and cost of internal maintenance.

Back-up Systems and Risk

There is a risk that institutions must be prepared to bear related to the implementation of instructional computing technology. With the increasing reliance on this technology, there comes the mandatory requirement that the systems always remain operational. This means that some duplicate hardware must be purchased. It may also be mandatory to cross-train the support staff in the operation and configuration of the systems. Excellent operational documentation must be prepared, kept current, and be readily accessible.

Some colleges have become increasingly reliant on computer networks for classroom use. For instance, English classrooms have been established that use on-line computer systems as the primary delivery vehicle in the teaching of writing. This technology can be of great benefit to the teaching/learning process. However, if the system is not operational for class, then it must either be repaired immediately or a back-up system must be substituted. Writing classes cannot be cancelled until the system is repaired. In some cases, staff must be prepared to work around the clock, if necessary, to restore the system.

The situation is analogous to on-line registration systems that many colleges operate. When the system is not operational, students cannot enroll. The effects will be similar with on-line classrooms. The risk of serious disruption increases as instruction becomes increasingly dependent upon technology. Adequate back-up systems and contingency plans become increasingly imperative.

Future Costs

Cost estimates for the project should include estimates for future costs related to maintenance, personnel, software, hardware, and utilities.

Increased demand placed upon instructional computing facilities may create a need for additional personnel. The type of personnel and the projected costs should be included in the estimate. Software packages are continually upgraded. Vendors frequently drop maintenance support for superseded software. The costs for software upgrades, software leases, and developing new software should also be considered.

The expected technological life of hardware continues to decrease, even though the durability of equipment may actually be improving. As a result, comparisons of the cost and functions of new equipment with the cost of maintenance and functions of the hardware on-hand need to be weighed when deciding to purchase or repair hardware.

Total Financial Requirements

The total financial requirements necessary to support the project should be specified in the plan, including hardware and software purchases, personnel, maintenance, curriculum development, installation costs, utility costs, and the cost of facilities or construction.

The plan should also specify all sources of funding for the project, both internal and external. Internal funding includes the current operating budget and any special budgets, such as supplemental or capital outlay funds. External funding sources include federal and state governments, business, and industry, and foundations.

Chapter Eleven
Implementing Plans

The success with which the instructional computing plan leaves paper and becomes reality is largely determined by the successful consolidation of all aspects of the strategic plan and various facilities plans, support organization plans, and numerous project plans into a single, unified, and coherent operational plan. The previous chapters have provided guidelines for developing a strategic plan for instructional computing and discussed important considerations in planning organizational structures and facilities to support instructional computing. This chapter concerns the development and implementation of an operational plan that transforms the collective wisdom and aspirations of a college with respect to instructional computing into actions.

Developing Project Plans

The goals and objectives of an instructional computing plan are the starting point for developing project plans. These plans are the smallest unit of planning that focus on very specific and discrete projects.

For example, a simple project is a faculty member using German word processing applications software as the medium for students to write essays in German. A more ambitious project is a chemistry faculty member attempting to use computer simulation to "perform" experiments that are either prohibitively expensive or too dangerous to do in an actual laboratory. A more broad-based project would be the establishment of a resource center equipped with sufficient hardware applications to support the general computing needs of students in all disciplines. Each of these examples is a discrete project, and in order to be implemented, each requires a detailed project plan.

Elements of a Project Plan. A project plan contains many of the same elements as more comprehensive institutional plans, but the focus is on the specific requirements for implementation.

Rationale. The project must identify and specifically reference the goals and objectives of the instructional computing plan that will be furthered by implementing the project. Similarly, the needs addressed by the plan should be specified and a rationale provided for how the project will benefit students.

Activities and Timelines. The activities that will be performed as part of the project need to be specified in detail. This includes identifying the individuals responsible to complete each task, as well as beginning and ending dates for accomplishing each.

Resources Required. The resources required to implement the project need to be specified, including the staff time required to research, conduct, manage, and support the project; the hardware and software resources required; supplies and other materials needed to support the effort; programming, technical, and instructional design support required; staff development and training required for project staff; and facilities and other institutional support needed to assist the project. The level of resources required should be translated into dollar amounts and a budget developed for the anticipated duration of the project.

Outcomes and Evaluation. A project should yield measurable results, and a project plan should identify as specifically as possible the outcomes that are expected to be the result of project implementation. Outcomes can be specified for the processes in which students or others will be engaged: the essays they write in German, the chemistry experiments they "conduct," or the number of times they use a resource lab. More difficult to assess but more meaningful are the learning outcomes that result for the project: the improvement in students' written German, increased understanding of chemical reactions, and student mastery of spreadsheets. The measures used to document student outcomes and the method of evaluation should also be specified.

Scope of Projects. Projects related to instructional computing objectives can vary substantially in scope, from the integration of foreign language word processing packages in language instruction to the building of a multi-million dollar facility to support instructional computing. Each is, strictly speaking, a distinct project, though they differ substantially in scope.

In general, it can be assumed that most projects for implementing instructional computing will be developed at the course, program, or department levels in a bottom-up fashion. An institution is not likely to undertake more than a few, carefully selected major projects with college-wide impact simultaneously, and these are likely to be planned with substantial input from administration.

The scope of a project has important implications for project planning. More comprehensive projects will generally require greater expertise in planning. Institutions should assess the internal expertise available to assist the planning process and identify the means of obtaining any additional assistance. Consideration should be given to involving external personnel in specific phases of the plan.

Vendors and Consultants. Vendors and consultants may be able to provide planning assistance. Vendor involvement in the planning process may relate directly to the purchasing power of the institution. The service may be free, or a nominal fee may be required. Vendors may participate in formal planning sessions, physical facilities planning, and application studies.

Consultants frequently advertise in trade magazines and industry directories. A consultant may also be located by contacting other institutions that have used consultants or that have personnel interested in consulting. Consultants possess specialized knowledge in a variety of fields crucial to project implementation. For a project of any magnitude, hiring consultants early, before any commitments to action are made, is highly recommended. It is prudent to require and examine references to insure that the expertise of consultants and any other service providers match the project's needs.

Institutions involved in large scale project planning will often designate an individual with decision-making authority as a project manager. The project manager establishes detailed plan objectives and timetables and coordinates planning committees, advisory committees, and consultants.

Obtaining Support for the Project

Given limited resources, projects will invariably compete for available funds. There are no hard and fast rules about the funding priorities that can be expected for any project. Those projects with greatest college-wide impact can expect the benefit of broad-based support, but if too large may still be more difficult to fund adequately. Small projects limited to a course or program may not only be more affordable, but may be viewed as models for other efforts.

Factors Affecting Approval and Support

There are any number of factors that affect approval and support for projects and conditions vary greatly by institution. The following represent those common to most community colleges.

Rationale. Because even the most politicized educational institution is inherently subject to rational argument, developing a strong rationale for the project in terms of stated institutional goals and objectives, student needs, and student learning outcomes can make a project unassailable. Of course, even the strongest rationale alone cannot overcome impossible funding problems or irresolvable turf battles, but a succinct and persuasive rationale for the project is the basis for obtaining support.

Policies and Procedures. The relative success of planning a project can, in most cases, depend upon the planner's understanding and adherence to established institutional policies, procedures, and practices. In some cases, this may not be as easy as it appears because of the possibility of conflict among these elements.

Decision-Makers. Planners must identify the college leaders and decision-makers through whom the plan must pass to achieve successful project conclusion. Knowing the established, as well as the informal, chains of command can help pave the way for acquiring necessary support.

Project Presentation. In those instances where a formal presentation is part of the process, the presentation should be targeted to its specific audience. Prior to the presentation, it may be helpful to learn the attitudes of key committee members about instructional computing, in general, and the project in specific.

Budget Development. Budgetary considerations are always the critical component of the project planning process. The relative financial condition of the institution and its ability to support capital-intensive projects will dramatically affect the outcome of such projects. Large capital projects may require implementation to be phased over a period of years. In such cases, it becomes necessary to identify priorities for implementation and to assure logical links among successive priorities.

Obtaining Seed Money. Because funding is such an important part of any project, it may be necessary to locate some external funding to provide momentum. The availability of seed money or the donation of equipment can go a long way toward convincing college decision-makers that a project has merit and support in the institution's larger community.

Alternative Approaches. Alternative approaches to achieve project objectives need careful study. Examination of the full range of alternatives early in the planning process can be critical to project approval. The project director should discuss alternatives with peers and decision-makers to help clarify ideas and begin to plant the seeds necessary to begin acquiring support for the plan.

Institutional Support. Broad-based support is critical for the approval and funding of a major capital project. The benefits of the project should be shared with peers, decision-makers, and end users, and their verbal and written support solicited.

Establishing a task force to assist in planning a project not only can provide the project planner a broader base of support, but also establishes a forum within which the planner's ideas can be shared and evaluated. The group may be able to provide assistance in writing, supporting, implementing, and evaluating the action plan. Demonstrating how the project will expand professional capabilities, ease workloads, improve performance, and bring similar benefits to faculty and students can persuade important constituents to support the plan.

The active support of the CEO is also a critical determinant of project success. The most persuasive argument to a CEO is one that identifies the positive expected outcomes that will accrue to the institution as a whole as a result of the project.

Resource Allocation

Projects are approved if they are funded and included in the development of the college's budget. Approval without funding is generally a meaningless gesture, unless funds are readily obtainable from external sources.

Most colleges adopt annual budgets. Many also develop budget plans for one or two subsequent years, while fewer develop long-range budgets. As a result, projects that require two or more years need to identify annual budget requirements as well as overall cost estimates. Most smaller projects can be accomplished within the context of a single budget cycle, though continuing support needs to be funded in subsequent years to support ongoing implementation. These continuing costs are the hidden costs of projects, and astute managers will request estimates of resources required to support long-term project implementation that become part of the college's base operating budget.

Again, resource allocation processes vary by institution and tend to be well-established. Consequently, detailed discussion of resource allocation will not be provided in this document. The only given is that plans must be funded to be implemented.

Consolidating Project Plans

Once funded, project plans—both large and small scale, long and short-range—need to be consolidated into a unified and coherent operational plan for instructional computing. The operational plan is the sum total of all projects and plans to organize support functions, build and equip facilities, train staff, and change or augment current instructional practices.

As such, the operational plan contains the same elements as project plans: specification of needs, goals, and objectives; delineation of activities, timeline, and responsibilities; identification of resources; and statement of intended outcomes and means to evaluate these outcomes.

The operational plan should be organized by the functional units of the college that will implement it so that individuals responsible for projects and adminstrators responsible for coordinating the efforts of project managers are clearly identified and accountable. In general, operational plans should be specified to the program and division level.

It is important to acknowledge that the plan, once developed, represents the best information available at the time. However, particularly in the area of computing, changing conditions may require changes in plans. Operational planning should accommodate such adaptation.

Communicating the Plan

Review and Approval. By whatever process, and in whatever form, an operational plan for instructional computing must be presented for review and approval by the institution's decision-making structure. The smoothness with which the plan is

reviewed and approved will generally be proportional to the amount of front-end involvement with a range of interested parties.

Such a review process sometimes uses a working group with the responsibility of synthesizing input and recommendations from interested constituencies to present a final draft of the plan to the responsible administrator. The administrator, in turn, reviews the plan and, when appropriate, moves it forward with a recommendation to the CEO and key college leaders for final review. If possible, the plan should, with the CEO's recommendation, be approved by the board of trustees or one of its appropriate committees. This gives the plan the highest level of institutional exposure and endorsement.

Communicating the Plan to End Users It is too often the case that a plan, once published, is carefully stored in a nice binder on the shelves of a few offices—despite the significant time and effort spent preparing it. The administrator with responsibility for the plan should take every step to assure that the college community is apprised of the plan, its implications for institutional and instructional operations, and its benefits to students. Wide distribution of the entire plan may not be efficient or even necessary. Key leaders should have the complete document, but other offices may need only an executive summary.

A special newsletter or some other type of written communication can be developed with highlights of the plan and what it means to the college community. References from the board of trustees, the CEO, the executive cabinet, and other approved planning documents can be included to lend credibility. Careful note should be made of any new policies and procedures. Solutions to unanticipated problems in the day-to-day activities of implementation should be recorded for incorporation into future releases of the plan.

Periodic progress reports should be disseminated, and user evaluations should be solicited as soon as implementation is initiated. Receptiveness to feedback about the plan and publication of this information can improve the instructional computing program and buoy a spirit of buy-in and cooperation for its continued success. It is important to give recognition not only to those who work on the plan but also to those who implement it. Suggestions from user groups and others who might be in a position to assess the effectiveness of the operational plan should always be objectively and openly received for consideration in future revisions.

Each institution involved with implementing a plan for instructional computing will find it necessary to relate the elements of an action plan to its own unique needs and institutional goals.

Factors Involved in Implementation

An operational plan should provide clear prescriptions for implementation. Individuals should be assigned to tasks, and provided with required resources. In turn, they should assure project completion according to a detailed timeline. However, in practice, nothing goes exactly according to even the best laid plans.

The following factors highlight some of the considerations that may affect the implementation of an operational plan specifically for instructional computing. Many of these have been touched upon in previous discussions, but these are reviewed here in terms of their impact on implementation of an operational plan.

Timelines. Accurate timelines are critical to the sound implementation of instructional computing projects. This element of the overall plan will let all of the different areas involved in the project development know when and how much of their support will be needed.

Grant Applications. If it becomes necessary to secure external funding from a grant source, all of the requirements of the grant and attendant timelines must be followed closely.

Budget Cycles. Planned use of institutional funds will require close attention to the internal procedures that must be followed. Sufficient lead time to gather all the necessary information and support for a project must be allowed.

Physical Facilities. Instructional computing projects that include building or renovating facilities must take into account the work schedule of the facilities department.

Equipment. Realistic purchasing and delivery schedules must be included in the overall project timeline. These should allow sufficient time for preparing specifications, competitive bidding, bid evaluation, board approval, and delivery of equipment.

Development and Testing. Timelines for all aspects of software design, development, documentation, and testing necessary to support the system must be given due consideration.

The timelines for instructional computing projects must allocate time for testing, training, and troubleshooting of the project as a whole. Even though the component parts of a project pass acceptance testing, the interrelationship of these parts as a whole can present problems. To ensure timely implementation, an appropriate amount of resources must be allocated for this portion of the project.

Support Organization. There are many good ways to organize support for instructional computing. Yet, all institutional components involved in supporting instructional computing should address the same functions to ensure a smooth transition from the concept to a tangible, operational project.

Purchasing. Simultaneous volume purchasing of all instructional computing resources is usually the most cost-effective manner in which to implement an institutional plan involving large equipment requests.

Installation. Instructional computing resources are expensive. Installation and acceptance testing must be accomplished by knowledgeable, well-trained individuals. Instructional computing resources should be delivered in a timely manner. The user should be trained in basic operation of the resources. These practices will help avoid costly mistakes.

Maintenance. The ongoing care of instructional computing resources is an issue that should be addressed by the procedures of a plan. There are two types of maintenance to be considered, preventative and ongoing. Preventative maintenance should be scheduled regularly. Ongoing maintenance, either by maintenance contracts or on a time and material basis, must take place as needed.

Design and Programming Support. The availability of appropriate instructional software is essential to the success of a project. The software may be purchased or locally produced by a production staff or individually by the faculty. In situations where faculty are also expected to design and write their own software, the institution should offer staff development activities designed specifically for assistance in this area.

In institutions where faculty are not expected to become systems analysts and computer programmers, necessary support services must also be provided. These activities usually require planning for significant additional support to complete the project, such as graphics, video production, instructional design, audio production, and project management.

It must be recognized that the faculty are responsible for delivering this technology in the classroom. Therefore, in order to gain maximum benefit from the project, faculty input must be considered and support for the faculty must be established.

The support staff should be involved in the initial project description to offer alternatives for implementing the project and to estimate the time necessary for full development. Design and programming support should begin as early as possible to ensure timely completion of the overall project; however, it should not begin until all the required institutional support is secured.

Staff Development. A comprehensive and coordinated staff development function is necessary to support the integration of computing into the curriculum. The coordination of this training can be provided by a centralized staff development office and supported by the members of the instructional computing faculty or staff. The computing staff can recommend appropriate training needs and provide instructors to offer the training. Training should be scheduled in the types of computer hardware and software supported by the institution.

Access and Literacy. Access to computing resources must be provided to promote computer literacy broadly among faculty and instructional support staff. However, it should also be recognized that access to computers will not necessarily insure literacy, and neither will literacy insure that the faculty will be able to implement their computer skills in the classroom.

Training Facilities for Faculty. If possible, separate training facilities for faculty and staff can be planned. This allows them to learn in a place where students will not interrupt or evaluate their progress. Quick access to support staff for assistance should be provided as possible.

Another alternative is to plan for a combined teaching and training facility. Staff development activities may be scheduled into the instructional computing facility when classes are not in session.

Training Classes for Staff and Faculty. One-on-one training is very expensive. If an institution has software standards, then training classes in applications software are fairly easy to implement. Classes can also be designed in a staged or sequenced manner. These classes will greatly reduce the load and improve the productivity of computer support staff.

Equipment Check-Out. Another important service

to consider for staff development is the check-out of microcomputers and appropriate software. This allows the institution to support faculty initiative. Documentation, manuals and even telephone help should be provided if possible.

User Groups. User groups can be a very effective way to share information about computers and to promote faculty and staff involvement with computer technologies on the campus. User groups can be organized into general or special-interest groups.

Newsletter. A newsletter for faculty and staff can be a valuable means of distributing information about various activities and projects on the campus related to instructional computing. Some specific items of merit might be survey responses, software reviews, new products, bulletin boards, and database sources.

Evaluating Success of the Plan

Evaluation can and should take place at various levels and stages in the implementation of a plan for instructional computing.

Evaluating the Plan. The plan itself should be subject to routine evaluation as to its usefulness in guiding the integration of computing into the curriculum and the instructional practices of faculty. Inadequacies of the plan document will become immediately apparent if timelines become unrealistic, allocated resources insufficient, or accountability for projects unclear. The plan should be regularly reviewed and revised to rectify such deficiencies.

The basic assumptions stated in the strategic portion of the planning document need to be evaluated periodically for continued validity. Changes in hardware and software standards and capabilities also need to be noted, and their effect on planned activities evaluated.

Evaluating Progress. Contained within all project plans and the overall operational plan are timelines within which to accomplish specific activities and tasks. These are the specific criteria for evaluating progress toward completion of tasks outlined in the operational plans. Such evaluation must be routine and continuous, the interval of the evaluations varying somewhat by the length of time allocated for specific projects.

The goals and objectives of the strategic plan also provide important criteria for evaluating progress toward their accomplishment. Goals and objectives are less specific and concrete than statements of activities and timelines, but they should be sufficiently detailed to allow an assessment of whether a goal has been "25 percent accomplished" or "mostly achieved." Such statements can assist a formative evaluation of how progress toward the stated goals and objectives of the instructional computing plan is proceeding and might be improved.

Evaluating Outcomes. The most complex and difficult evaluation is to determine what outcomes for students, faculty, and the institution have resulted from the implementation of computers in instruction.

Student Outcomes. Student outcomes are the appropriate principal focus of such an evaluation. The pertinent question is what have students learned as a result of using computers in various disciplines. Have they learned more than they would have otherwise? Is the nature of student learning different as a result of computer use? Are they better prepared for further education, the workplace, or for informed citizenship?

While these are the important questions, most evaluations can only scratch their surface. Most student learning outcomes are difficult to measure; even elaborate efforts to pre- and post-test student achievement are not certain to measure the effect of the instructional medium used. Student gains in computer skills can be readily assessed, and assessing these gains should be part of any evaluation of the outcomes of instructional computing. However, differences in quality and quantity of student learning for those using computers and those not using computers is confounded by an appropriate unwillingness to deprive a control group of students access to tools as powerful as computers.

Measures of student computer use, their satisfaction with the medium, their persistence in courses and to program completion, their selection of courses using computers, and various other indicators do not evaluate outcomes but do provide some indication of the success of the implementation of instructional computing.

Faculty Outcomes. Faculty learning outcomes are similarly difficult to measure. Because faculty learning is not an end in itself, but rather a means to the end of student learning, attempts to measure it are probably less critical. Nonetheless, faculty computer skills can be indirectly assessed by their level of use and their success in integrating computers in their classrooms. Practices for evaluating faculty performance vary widely across institutions,

and the inclusion of criteria related to computer skills and ability to instruct effectively using computers as tools or media is likely to be a local option. Faculty perceptions of the effectiveness of using computers in instruction should be regularly assessed.

Institutional Outcomes. The most general level of evaluation involves the assessment of the overall impact of instructional computing on the institution. Morale, public perception, and institutional prestige can be affected by implementing instructional computing, but these outcomes are tricky to assess and generally are long-term effects. The number and characteristics of students attracted to the college's curriculum are also critical long-range institutional outcomes. The cost-benefit ratio of using computers throughout the college is a legitimate measure. However, benefits are difficult to quantify to serve as the denominator of the equation. Also, short-term costs are likely to be high and, therefore, will skew the ratio. Over the long-term, an institution may be able to demonstrate actual reduction in costs.

The real effects on an institution of integrating computers into its curriculum are generally long-term. Therefore, its decision to develop and implement plans for instructional computing must be based upon its faith and good judgment that computers represent some of the best tools available to accomplish its instructional missions.

Glossary[1]

applications software — A category of software that is used to perform common operations, including word processing, spreadsheets, database, graphics, desktop publishing, and communications.

artificial intelligence — The use of computers to solve problems that were previously believed to require human intelligence for solution.

authoring tools — Software designed to allow non-programmers to design and write their own programs. This is a very popular means for educators to create courseware.

boards — An electronic component of computer hardware. These are usually removable, rectangular in shape, and serve as support for the many necessary electronics required by computers such as chips, resistors, diodes, capacitors, etc. Boards (also known as "cards") are often named according to the primary function they serve, e.g., motherboard (the primary board in a computer), graphics board, video card, etc.

bulletin board — An information system which provides online access to news, bulletins, messages, databases, programs, and special interest group (SIG) conferences via modem.

CAD — An acronym for "computer-aided drafting." Frequently used in conjunction with CAM, as in CAD/CAM.

CAI — Abbreviation for "computer-aided instruction."

CAM — An acronym for "computer-aided manufacturing." Frequently used in conjunction with CAD, as in CAD/CAM.

CD-ROM — An acronym for "compact disc-read-only memory." This is a data storage medium, which looks exactly like an audio compact disc, and is designed to be read by a laser device in a disk drive. Read-only memory means that you cannot "write" data to the disc, but only access the information that is placed on it by the producer.

clone — Refers to a computer that uses the same hardware architecture and operating system as one of the major computers on the market, i.e., IBM or Macintosh. Usually clones (also known as compatibles) are less expensive than the computer they are copying.

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[1] Members of the task force wish to acknowledge the special contribution of Carolyn Guyer, Johnson County Community College, Overland Park, Kansas, for compiling this glossary.

courseware	Software designed to deliver instruction, frequently in an interactive style.
data file translation	Conversion of information from one computer environment's characteristic format to another's.
database	Information stored in a defined structure that allows access and update.
debugging	The process of correcting errors in a program or system of programs.
desktop publishing	A category of software that allows the organization and layout of text and graphics created in other programs.
disaster recovery	All computer systems face the almost certain eventuality of sudden and unexpected loss of data. Any organization which deals with information too valuable to be lost should always operate under a disaster recovery plan which usually involves a series of backups, off-site storage, and other means to prevent absolute loss of large amounts of data.
disk drive	A device used to "read" data from, or "write" data to, a storage medium, e.g., a diskette..
distributed processing	Data processing done in different locations for a common goal.
download	Refers to a computer receiving a file of information from another computer. Used in contrast to upload.
electronic mail	A system designed to allow sending and receiving messages via computer networking.
environment	As a computer term, this refers to the user interface style and/or hardware architecture of different computer operating systems. Most frequently used to contrast MS-DOS (IBM) with Apple's Macintosh.
expert system	One of the primary types of software created under the umbrella of "artificial intelligence." An attempt is made to elicit from an expert of some kind (e.g., plumber, auto mechanic, papermaker, teacher) all of her affective knowledge in the area of her expertise. That knowledge base is then written into a program that automates and makes more widely available, or cheaper, the formerly exclusive domain of the expert. The creation of an expert system is always difficult and sometimes impossible, since eliciting all the necessary knowledge from an expert who "knows" largely by intuition and experience can be a confounding process.
file server	The central storage and delivery system of data and programs on a network, normally a large capacity hard disk drive attached to a micro or mini system.

halon A chemical means of fire prevention.

hard drive A disk drive with a magnetic disk fixed in place. These drives provide greater data storage capacity than the so-called "floppy" disks. Hard drives can range in storage size from 10 megabytes upwards of 1,000 megabytes (or 1 gigabyte). A megabyte is roughly equivalent to 300 pages of text.

hard-wire connection A physical connection of computer devices by cabling.

hardware The physical parts and components of a computer. This term is usually used in contrast to software.

hypertext Refers to information organized for non-sequential, interactive reading. Education is one of the primary users of hypertext in its current stage of development. A related, and often interchangeable, term is "hypermedia," which refers to the incorporation of multiple media, such as video, sound recording, etc.

instructional approach An instructional approach is the strategy used to facilitate student learning of a subject matter. Exposition, dramatic re-enactment, role-playing, drill and practice are examples of instructional approaches.

integrated software A software package comprised of several modules, each performing different functions, such as word processing, spreadsheet, data communications, database, etc., and having the capability of interfacing. That is, database information can be pulled directly into a word processing document, and so on.

interactive video A video system that is controlled by computer which allows the user to access the information stored on the video.

LAN An acronym for Local Area Network. This is a networking of computers in a restricted geographical area, usually at an outside range of one mile. Most frequently, LANs are set up within a single department, company, or institution.

mainframe A term used to differentiate large computers having very powerful processing capabilities and large numbers of simultaneous users from the less powerful machines, minicomputers and microcomputers.

medium A medium is a means for implementing an instructional approach, i.e., an instrumentality for transmitting information. Video, live-presentation, and computers are examples of media. Media can be combined as in interactive video disc: a combination of the computer and video disc media.

microcomputer Also called "personal computers," these are stand-alone machines which are on the low end of the range of computer processing power. Computer mavens are fond of noting that today's micros have as much processing power as early mainframes.

modem	Contraction of "modulator-demodulator." A device that converts computer data (digital) to audio signals (analog) for transmittal over phone lines. Modems are used to network computers for communications.
multi-user operating system	Software allowing multiple users to access a single computer simultaneously.
network	The connecting of several computers for the purposes of sharing data and software, sending messages, sharing peripherals, etc.
online	Establishing a successful connection for communication between two computers.
operating system	The software designed as the necessary interface between specific programs, such as word processors, and the actual electronic components of the computer. All computers must have an operating system installed before any other program will work.
optical scanner	A device that "reads" the text or graphic images on a page and converts them to digital information for a computer.
optical storage device	Any device, such as a CD-ROM, which stores information to be read by a laser. This is in contrast to magnetic media.
peripherals	External devices, varying in function, and connected to a computer for added capability. Some examples: printers, scanners, disk drives, plotters, etc.
plotter	A form of "printer" which employs special pens to draw on paper the lines of a graphic or textual image created on a computer.
print queue	Computer memory reserved for holding a prioritized group of jobs which are to be printed; that is, the jobs wait in line to be printed.
program	A coherent and usually complex set of instructions that tell a computer what to do in order to provide computer users with processing functions within the parameters of specific software categories, e.g., word processors, databases, spreadsheets, etc.
programming language	An "artificial" language designed to allow a programmer to write a set of instructions to a computer. The instructions are usually in symbolic form.
programming	The act of writing a program using a programming language, authoring system, or commands embedded in an application program.
public-domain software	Programs made available to the public without charge.
read-only memory	See CD-ROM.

RFP Abbreviation for Request For Proposal.

server A device on a network that provides a specific service, for instance, a printer, an optical scanner, or a hard disk drive.

shareware Software made available to the public without charge, but which is not free. The designers, true to the idealistic spirit of many of the early "hackers," believe that an innate sense of fairness will prevail in users of their software, and that they will be recompensed in the amount they state within the program. Needless to say, this admirable plan doesn't always work as hoped.

smart data switches An electronic device with a microprocessor which controls and/or directs the flow of computer information.

software The instructions that tell the computer what to do. These are usually in the form of a program which is stored on a magnetic medium such as a diskette or a hard drive.

spreadsheet Software designed to facilitate accounting tasks and other tasks which lend themselves to a matrix format.

synthesizer A device that produces sound from electronic circuitry

technical approach There are two basic technical approaches for using computers. The first approach is called ad hoc frame-oriented (Carbonnel, 1981) computer-aided instruction. In this approach, everything to be presented to the student is prepared a priori. Thus the computer becomes a super-slide projector where each prepared slide can be text, graphics, a video segment, etc.

The second approach is called generative computer-aided instruction. In this approach the computer generates the specific information presented to the student based on some formula or set of instructions. A simple example would be a program which generates addition arithmetic problems of the form A + B = ?. The computer randomly selects values for A and B, calculates their sum and compares that with the student's answer.

telecommunications In its most restricted sense, telecommunications refers to the transmission of data from one computer to another via telephone lines or satellite transmission. The term is also used broadly to include the projection of audio, video, and/or data over distance, for instance, as in television courses or teleconferences.

test generator Software used to automate the creation of examinations.

upload To send a file of any information from one computer to another. Used in contrast to download.

user group	An organization which serves as a resource for computer users. Usually, Special Interest Groups (SIGs) are formed as subgroups within the organization.
user interface	The part of software design that allows a user to access the functions of a computer. Pull-down menus, graphic icons, and commands to be typed in via keyboard are examples of user interface.
word processing	The activity of manipulating text within a program designed for that function. Most word processing programs provide for easy correction of mistakes, spell checking, moving of large blocks of text, "automatic" formatting, among many other standard features.
workstation	Usually refers to a stand-alone computer which is more powerful than a microcomputer, and intended for use by an individual as opposed to multiple users.

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